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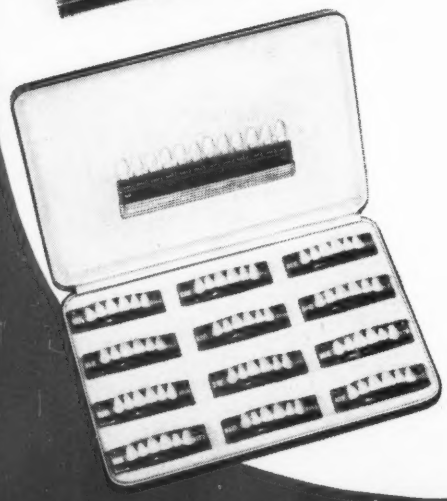

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THE JOURNAL OF PROSTHETIC DENTISTRY

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THROUGH THE EYES OF THE EDITOR

John Victor Niiranen criticizes the way in which diagnostic records are made and used in everyday practice. His observations regarding these records and procedures are too obviously correct. This is unfortunate because the practice leads to denture failures which could have been avoided if an adequate diagnosis had been made *and used*. He divides the process of diagnosis for complete dentures into four major classes. This simplifies the problems to a great extent. He properly emphasizes the importance of recognizing oral manifestations of systemic disease, and lists the important symptoms of several of these diseases. He recommends the selection of the impression method according to the conditions in the mouth. Sound reasons are given for the various choices. Many suggestions as to technical procedures are made, and these should prove helpful in the application of the diagnostic information. The statement that "diagnosis is a continuing process" provides much food for thought. The final step in diagnosis can not be taken until the dentures have been inserted, and even then further diagnosis may be necessary for certain patients.

Henry A. Collett discusses the forces that retain dentures, and describes a technique for making final impressions in an alginate impression material. He attempts to combine border form control with close adaptation of the impression surface of the denture to the tissues it contacts. The method seems to overcome at least a part of the objections to the use of alginate as an impression material for complete dentures. The key to successful use of this material is the properly designed and constructed *individual* tray. Like all other impression techniques, this one depends for success upon the knowledge and skill of the dentist making the impression.

H. A. Young discusses the objectives and problems of the selection of the forms of anterior teeth, and describes various techniques which have been used for this operation. The fact that twenty-one techniques have been suggested indicates the need for a satisfactory guide rather than a disagreement. Other techniques could have been added to this list, for each dentist sees his patients through his own eyes and makes determinations as to harmony of form and size which satisfy his own sense of beauty. Techniques of selection can serve as guides, but, in the final analysis, the accuracy of selection depends upon the artistic skill and the esthetic sensitiveness of the dentist. The basic principles of selection can be tied to techniques, but strict adherence to a technique will produce stereotyped restorations with the characteristic similarity of mass production. The need is for more individual thought and care in the interpretation and application of selection techniques to each individual patient. The greatest danger in the selection (and arrangement of teeth is in the almost universal tendency to make the dentures look alike for all patients.

Victor H. Sears challenges some of the current concepts of denture service and points out what he believes to be their fallacies. He states, "Outstanding prosthodontists have contributed a great fund of information as well as a certain amount of misinformation." Dr. Sears is an outstanding prosthodontist and would be the first to admit that his concepts are subject to the same reappraisal as the concepts he criticizes. This article should be read with an open mind in order that "thought, discussion, and experimentation" will be stimulated as he hopes. The mere fact of "newness" of a concept does not make it the correct concept, but, likewise, it is not neces-

sarily wrong because it is new. Many of the suggestions he makes are excellent, but others should be considered with care and reservations. The suggestions regarding diagnosis and treatment planning should be most helpful, and those regarding esthetics are good provided the dentist has sufficient artistic ability to carry them out without producing a mechanical esthetic effect. The suggestions regarding the occlusal scheme are controversial, and the use of occlusal pivots may be open to question. It could be that the apparent need for occlusal pivots is, in part, the result of an occlusal scheme which does not compensate for the drop of the condyles that occurs along with any protrusion of the jaw. Occlusal pivots could be desirable also, if dentures are worn too long without proper servicing. It seems unlikely that the *body* of the mandible would "bend," especially at the age that this is supposed to occur. It seems more likely that the "bend" would occur while natural teeth were in place only in the anterior part of the mouth. There can be little disagreement regarding the desirability of maintaining the occlusal load in the posterior part of the mouth. The question is how can it be done best.

Felix A. French disagrees with those who believe that esthetics are more important in "satisfactory dentures" than the other two functions of dentures, especially when the other functions suffer by this emphasis. He states that dentures must be mechanically correct if they are to be satisfactory. He blames faulty occlusal patterns for most denture failures. He criticizes the term "anatomic" when it is used to designate teeth with cusps. The point is well made that no artificial tooth is anatomic. He recognizes the fact that the anatomic foundation is not stable and that it does change with time. On the basis of this recognition, he suggests that teeth without cusps will do less damage to the supporting structures by eliminating the lock between cusps. He claims that teeth without cusps will produce less lateral force on the supporting ridges than teeth with cusps. This is still a controversial subject, and it should be considered in the light of some current research. All diagrams of "lines of force" against teeth are only a part of the story *unless* they take into consideration the direction of closure. This has been shown to vary with a number of factors. Clinical evidence will never provide the answer to this problem because of the many variables in the clinical application of the many concepts of occlusion. Each dentist has his own individual skill (or lack of it) in developing any given type of occlusal pattern. Some are more efficient with one kind of teeth and some with another. The consideration for a bilaterally balanced occlusion, regardless of tooth form seems to be worthwhile.

Charles H. Moses discusses biomechanics and artificial teeth and describes his procedure for the development of the occlusal pattern for complete dentures. He asks why "denture-wearing patients get along fairly well" even though their dentures were made without the use of an adjustable articulator and the face-bow. The answer must be that it is due to the skill and accommodation of patients to appliances which they believe to be the best that dentistry can do. The fact that patients can adapt to these dentures does not indicate that this is adequate service. The variations of direction and magnitude of the masticatory stroke and of other jaw movements are pointed out as being controlled by the neuromuscular system. He states that "occlusion is not the terminal position of the masticatory stroke." This statement is at variation with his previous discussion. Who can say that occlusal contacts are not made at the end of *some* masticatory strokes by some patients? In the discussion of the mechanical requisites for posterior tooth form, some of the statements seem to border on teleologic reasoning. Bruxism in correctly pointed out as being a common source of denture difficulties. He uses teeth without cusps to minimize the damage caused by this activity. The reverse occlusal curve is used to favor the stability of the lower denture. It is odd, though, that the most difficult problems arise with upper dentures when their support is unfavorable. Stability of lower dentures seems to be easier to obtain than that of upper dentures with equally unfavorable support. The occlusal scheme which he suggests includes provision for a bilaterally balanced occlu-

sion. The procedures for developing his objective in an occlusion are simple enough to be practical, even though they include the use of posterior tooth forms which are specially made for each patient.

Joel Friedman discusses partial denture designing on the basis of the position of abutment sites and edentulous spaces. This is done by applying his A B C partial denture classification. He relates his analysis to the function expected of each segment of the denture. The various types of movement during function are described and compensating changes in design are suggested for them. The outline of procedure for analyzing the problems of design of partial dentures should prove helpful.

S. Charles Brecker believes that the two important objectives of extensive restorative dentistry are esthetic improvement and functional occlusal improvement. He discusses the plan for treatment of patients needing this service. He points out differences of opinion regarding procedure and instrumentation. He apparently feels that the temporomandibular joint has less influence on occlusal reconstruction than some other writers. He chooses the mouth as the articulator, in spite of this opinion, because it is the most accurate and individual for each patient. The mouth is the environment in which the occlusion must function but it has the disadvantage of not being completely within the control of the dentist. It does have the advantage of capability of movements which a mechanical articulator cannot reproduce. He points out seven limitations in oral rehabilitation, and warns against indiscriminate increasing of the vertical dimension of occlusal contact. He divides patients needing extensive restorative treatment into two groups and describes the procedures which he uses for each group. In planning this work, he considers the service the various restorations may need after they have been used by the patient. This important factor is frequently overlooked in contemporary practice.

Harry Kazis suggests the integration of all biologic and functional factors of occlusal reconstruction with the mechanical factors. He points out a common error in restorative procedures—the repacement of missing teeth without due regard for the physiologic factors of vertical dimension, free-way space, and balanced occlusion. He places proper emphasis on the importance of the "functional" factors of these restorations. His discussion of centric relation must be classed as controversial. His use of a double exposure laminagraphic roentgenogram of the temporomandibular joint is most interesting and is worthy of further investigation. However, it seems that a diagnosis made with this evidence alone would be unreliable. The relatively small positional changes of the condyle during mandibular movement from rest position to occlusion would be difficult to see in a laminagraph. It would be like trying to tell time by watching the central axis of a clock rather than the hands. When the laminagraphic technique is correlated with other procedures, it can be valuable. The suggestion that centric relation be recorded while closing force is applied may be satisfactory for tooth supported restorations, but it would be open to question for soft-tissue-borne restorations.

Harry J. Healey suggests the proper correlation of restorative procedures with the endodontic treatment of pulpless teeth. The increasing use of adequate endodontic treatment of teeth requires greater attention to the special problems of restoring treated teeth. The various restorative materials and techniques are evaluated.

Charles Newman and Grant Van Huysen report their studies of the histologic reactions of the oral tissues of the dog to chrome cobalt implantations. The technical procedures of the implantation were similar to those used in denture implantations for patients. The results thereby become more significant. The conclusion that "implantations are held in place by a dense fibrous connective tissue envelope and not by rigid fixation to bone" should indicate some possible modifications of the design of implantations. The presence of inflammation about the post indicates the need for further study of the relation of implantations to inflammatory processes. It is to be hoped that more basic research such as is reported here will be done.

—Carl O. Boucher

DIAGNOSIS FOR COMPLETE DENTURES

JOHN VICTOR NIIRANEN, D.D.S.*

Bethesda, Md.

HUMAN BEINGS are prone to adhere to action patterns which originated in the past, and in many situations this adherence results in helpful customs and beneficial conventions for contemporary living. In some cases, however, adherence to traditional practice may fail to contribute to, or may even impede, the solution of current problems. In such cases it is complete folly to continue the practice of certain methods simply because they were used years ago.

A case in point is diagnosis as a step in the fabrication of complete dentures. We have inherited from the past a diagnostic record, or sheet, which we fill out with column after column of information about the patient—information that is of little clinical interest to us in the fabrication of complete dentures. For example, some diagnostic sheets have large sections devoted to the well-being of distant relatives. It is generally conceived that diagnosis is completed upon the initial visit of the patient, and, at that time, subjects and data are often evaluated and entered on diagnosis sheets, despite the fact that certain relevant information is extremely difficult to obtain until the maxillary and mandibular casts are mounted on an articulator. Yet the diagnostic sheets, as originally filled out with detailed information, are most often filed away after the initial visit, and are not referred to at any time.

It is the writer's belief that diagnosis is a continuing process, and that a practical, careful diagnosis must be carried on as it is needed at each step in the fabrication of the prosthesis. Diagnostic sheets may, after some pruning and revising, constitute a good reference, if they are properly used, but the diagnosis itself should remain simple and practical, and it should develop continuously with the progress of prosthesis fabrication. To present a practical method of diagnosis along these lines is, then, the purpose of this paper.

Diagnosis of oral conditions which may or do require complete dentures falls into four major classes:

1. Conditions involving full-mouth extractions.
2. Conditions of the edentulous mouth.
3. Conditions involving immediate dentures.
4. Conditions involving faulty existing dentures.

The opinions or assertions contained herein are the private ones of the writer and are not to be construed as official or reflecting the views of the Navy Department or the Naval Service at large.

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I. CONDITIONS INVOLVING FULL-MOUTH EXTRACTIONS

When patients put themselves under the professional care of a dentist with a request for a full-mouth extraction, it is his duty to make an accurate diagnosis. The big question is: Should the teeth be extracted or can they be retained? The question can be answered only by a careful diagnosis which includes roentgenographic and clinical examinations, together with an inquiry into the patient's medical history. The greatest care must be exercised to recognize dentitions which can be salvaged entirely or in part.

If the medical history is negative, the most common reasons for full-mouth extraction are rampant caries, esthetic considerations, periapical infection, periodontal disease, malocclusion, and injury.

Extractions for rampant caries are not always indicated until an anticarious regimen has been tried. It might consist of topical fluoride applications, proper oral hygiene, a sugar-free diet, or any other accepted method. It may be advisable to place temporary restorations in carious areas while the patient is being observed.

Patients often ask the opinion of the dentist in problems of esthetics. They complain most frequently of stained teeth, congenital anomalies, malarranged teeth, and numerous faulty restorations. The problem usually is not one of esthetics alone. Because of the four complaints mentioned, there usually has been a loss of tooth structure and of supporting structures. If a mental problem is involved, the diagnosis should be carefully discussed with the patient and with the patient's physician. Extraction of the remaining teeth, if accomplished at all, should be primarily for mental comfort of the patient, and any esthetic improvement which occurs should be coincidental and not intentional.

Teeth with periapical lesions are usually extracted, unless they are good risks for endodontic treatment. Among the contraindications for endodontic treatment are periapical lesions in the posterior teeth, obliterated pulp canals, internal resorption, and a communication between a periapical lesion and the gingival crevice. Periapical lesions may contribute to many systemic complaints.

If the diagnosis is periodontal disease, a periodontist should be consulted. If the natural teeth can be restored to satisfactory function without undue motion, and can continue to function without further loss of supporting alveolar structures, the teeth should be retained. We must recognize, however, the point at which too much destruction of the supporting tissues will result in an unsatisfactory supporting area for a denture.

Extraction for malocclusion is seldom desirable. When dentures replace the natural teeth, the malrelationship of the jaws will still exist, and will result in problems. Usually, careful equilibration, restoration of vertical dimension by occlusal splints, or partial dentures will solve the problem adequately.

Sometimes patients have had facial injuries that require extraction of all of their remaining teeth. The extraction may be due partly to economic reasons, for the rehabilitation of an injured patient may often be very expensive.

II. CONDITIONS OF THE EDENTULOUS MOUTH

Let us turn now to the second class of conditions. Here we find problems of diagnosis in patients who have edentulous mouths.

The question which the edentulous patient presents is not: Does he need dentures? It is: How will the dentures be fabricated particularly for him? A medical history from the patient, or the patient's physician, should be available to determine whether the prognosis of the complete dentures will be influenced by some treatment or disease.

It is also important for the prosthodontist to be familiar with systemic diseases that manifest themselves in the oral cavity. He should recognize signs indicative of certain diseases for his own and his patient's advantage. He also should be familiar with procedures dictated by the conditions within the oral cavity.

Following are a few of the most common diseases encountered in the practice of prosthodontics, with a brief comment about the diagnostic signs and prosthetic procedures related to each.

DIABETES

The following diagnostic features are in evidence in diabetes: a dry feeling in the mouth; a coated tongue, with swollen edges and tooth impressions along the borders; fissures on the tongue; small abscesses throughout the mouth; poor tissue tone; and a burning and metallic taste in the mouth. A faint odor of acetone is evident in advanced cases, and the patient should be treated medically before any dental procedures are begun, because dentures may be debased by the action of acetone.

How are these problems met by the prosthodontist? The patient must have this condition under good medical control. This is important, for the success of dentures goes hand in hand with medical control. The operator should use a nonpressure impression for maximum physiologic compatibility of the denture base with the supporting tissues. Careful occlusal corrections should be accomplished to remove all interferences. The food table should be small, and the patient should be given detailed instructions on eating habits and mouth hygiene. Periodical adjustment of dentures is necessary. If the patient has an insulin shock while you are treating him, place some sugar in his mouth. He usually carries some on his person.

ARTHRITIS

The oral aspects of arthritis are usually seen in the temporomandibular joint. These are limited movement and opening, generalized pain throughout the side of the face, abnormal chewing procedures, and changing occlusal relations.

The problems for the prosthodontist are then as follows: The limited opening of the mandible during impression may necessitate special trays and procedures. It may be difficult to get proper jaw relation registrations, and the technique may have to be changed. Probably the tactile method is the most satisfactory. Occlusal corrections must be made often because of arthritic changes in the temporomandibular joint.

BELL'S PALSY

Bell's palsy is a toxic, infective, thermal, or mechanical overstimulation of the facial nerve, which results in facial asymmetry, lack of muscular control on the affected side, failure of the eyelid to close normally on the affected side, excessive tearing on the paralyzed side, dropping of the corner of the mouth, and emission of saliva.

In fabricating complete dentures, the following problems develop: Retention is often difficult to achieve, and an adhesive may be necessary. Support becomes a problem. Both function and esthetics emphasize the importance of support for the paralyzed musculature. It can be accomplished by using plastic, or modeling plastic, or wax plumpers. Proper use of the dentures is a problem, and the patient should be educated in mastication and mouth hygiene.

PARKINSON'S DISEASE (PARALYSIS AGITANS)

Parkinson's disease is characterized by rhythmical muscular tremors which include the tongue and muscles of mastication, muscle rigidity, which is usually evident, very slow movements by the patient, excessive salivation, and a fixed masklike expression.

Control of the patient during fabrication of the denture can be accomplished with sedatives. Retention is difficult, and an adhesive may be necessary. It may be wise to remove dentures when they are not in use. This will add to the comfort of the patient, and eliminate the danger of swallowing them.

ANEMIA

Various types of anemia present the following generalized symptoms: changes in the mucous membrane; pallor of the tongue and lips; burning, smooth, glossy tongue; and usually pain in the tongue and supporting areas.

It is important that these patients first be placed under good medical care. Next, the dentist must achieve: good mouth hygiene; efficient dentures, since diet is such an important part of the medical treatment; a small food table with the maximum supporting area to keep the supporting tissues from being overstimulated; careful patient instruction.

TUBERCULOSIS

Oral lesions are not common in tuberculosis, but when present they show long, deep fisures on the tongue; lesions on the mucosa of the check; round, undermined ulcers that are very painful; firm nodules; and a medical history of tuberculosis. These lesions will not respond to any local treatment.

The following precautions and procedure should be followed: Diet is important in treatment, and comfortable, efficient dentures are, therefore, necessary. The best possible mouth hygiene should be accomplished, because oral infections add to the load of general resistance. Irritating projections on the dentures must be removed, so that they will not erode the skin and start tubercular lesions. The

dentures must be checked often, to minimize irritation. The patient may have to be kept prone while dentures are being fabricated. Such a procedure may alter the technique of fabrication; for example, it may be necessary to alter the impression and registration procedures. The dentist must protect himself from infection. He should make a thorough, careful scrub, and wear a mask and gloves.

LUPUS ERYTHEMATOSUS

Lupus erythematosus is a type of dermatitis, although it is often thought to be lichen planus or leukoplakia. It presents dermatitis on the face, a dry and atrophic affected area, scales over the lesions in most cases, sharply demarcated white patches, and bases that are red with some edema. Dentures can be worn because the lesions are not usually on the denture-bearing area. Occasionally some lesions are present on the hard palate and need only relief. Good mouth hygiene is important, and periodical checks of the dentures must be performed to minimize irritation. The polished surfaces of the dentures must not irritate the lesions.

PEMPHIGUS

Pemphigus is the most often fatal of the dermatologic diseases. Orally it presents vesicles and bullae on the mucous membrane as well as on the skin. When the vesicles rupture, they leave eroded areas and ulcerations, and the resulting condition causes discomfort and pain. A foul odor is usually present in the oral cavity, and loss of body weight is readily apparent. The disease is often found in older Hebrew women. Medical treatment is necessary for any degree of comfort. Supporting tissues are too painful to permit the wearing of dentures, and they should be worn only for mastication and mental comfort.

PLUMMER-VINSON SYNDROME

Women are primarily affected in the Plummer-Vinson syndrome. The symptoms are anemia; dysphagia; atrophy of the oral mucosa; smooth, enlarged, red, dry tongue; oral mucosa dull in color, very thin, and painful; and a small mouth opening, with fissuring of corners. Malignancies are common in this group of patients.

Medical treatment is required before dental procedures can be initiated. The problem of impressions and registrations is difficult because of the small mouth opening and the tissue atrophy. Since poor tissue tolerance to stimulation is evident, a nonpressure impression is indicated. The dentist must be very careful not to permit any irritation to be caused by the dentures, for these patients are very prone to malignancies in the oral cavity. The dentures should be checked every few months for comfort and occlusal harmony.

RADIATION

Radiation is an extremely complex subject, and several articles could be written on it alone. Though we can do no more than mention it, we must re-

member the following facts: Recent radiations show bronzing and burning of the external layers of the skin at the site of the port. Loss of hair takes place in the port area. Intraorally we see diffuse scarring and slightly pale tissues which are firm on palpation. Roentgenograms of the area may reveal radon seeds previously implanted.

When radiation has been accomplished five or six years prior to our examination, we notice atrophy of the external layers of the skin. The vessels are close to the surface, and we observe definite scarring. If a roentgenogram shows very dense bone, but no visible signs are seen intraorally, we may be very sure that radiation has been accomplished several years prior to our examination.

If dentures are to be worn, we must be completely *certain* that no abrasion or irritation is present on the supporting tissues. An open lesion may be the start of a serious condition. It is best not to use dentures at all over radiated tissues.

NICOTINIC STOMATITIS

Nicotinic stomatitis is a form of chemical injury to the oral mucosa and mucous glands. It is usually seen in people with fair, sun-sensitive skin. The first signs are usually seen on the hard palate. The mucosa is gray in color with raised, red papules. An excessive secretion from the mucous glands is present.

The area can be covered with a denture. Even in patients with natural dentitions, the area is covered as part of the treatment. Because of excessive secretion from the mucous glands, plaster is the impression material of choice.

CLEIDOCRANIAL DYSOSTOSIS (CROUZON'S DISEASE)

The following conditions exist in cleidocranial dysostosis: The clavicle is missing entirely or in part, so that the patient can bring his shoulders together. Most of the teeth are unerupted and impacted. The maxilla is so small that the patient looks prognathic. Such patients usually have large heads and short bodies. Roentgenograms show supernumerary teeth with abrupt bends on the roots.

The prosthetic treatment calls for fabrication of the dentures over the unerupted teeth. Teeth should be removed as they erupt, for very little supporting bone structure would be left if the supernumerary, impacted, unerupted teeth were all extracted at once.

ECTODERMAL DYSPLASIA

Ectodermal dysplasia is a condition seen in young children. It is associated with other ectodermal conditions, such as defective skin, hair, and nails. Orally, the condition is characterized by either complete or partial anodontia, and in the latter case, the remaining teeth are usually very poor.

Complete dentures should be fabricated if any remaining teeth are too poor to be retained. Prosthetic procedures help both esthetics and function, and they lead to a great improvement in the mental outlook of the patient. The dentures should be remade periodically to keep up with the growth of the child.

One other precaution is necessary. Many of these patients are unable to perspire normally, and care must be taken in the office to provide the optimum temperature for patient comfort.

SCHÜLLER-CHRISTIAN DISEASE

Following are the diagnostic features of Schüller-Christian disease: exophthalmos, due to fat cells around the eyes; defects of the membranous bones, shown in roentgenograms as a moth-eaten appearance with sharply defined borders; swollen, spongy tissues in the mouth; generalized pain, often present in the mandible.

The dentist should insist on careful mouth hygiene. He should remove all foreign bodies, because of possible radiation treatment of the condition, and should use a nonpressure impression to achieve the minimum displacement of the supporting tissues.

OSTEITIS DEFORMANS (PAGET'S DISEASE)

Osteitis deformans is a chronic osseous disturbance characterized by hypertrophy and bowing of long bones, irregular enlargement and deformity of flat bones, enlarged skull, with a dull pain in the involved bones, and a cotton-wool appearance of the skull in roentgenograms. This condition can be recognized even in dental roentgenograms. The continual enlarging and changing of supporting structures, especially the maxillary tuberosities, necessitate frequent remakes and adjustments of dentures.

ACROMEGALIA (HYPERPITUITARISM)

Acromegalia is easily recognized by the following characteristics: square face, large protruding mandible, massive cheekbones, heavy cranium, deep-set eyes, prominent frontal eminences, large heavy nose, thick lips, large tongue, and large hands and feet.

To satisfy prosthetic requirements, make a periodic check of the prosthesis to determine whether the continuing growth of the mandible and maxilla necessitates any adjustments of the prosthesis.

LEUKOPLAKIA

Leukoplakia is a term which is loosely applied to smooth, white, diffuse patches on the mucous membranes of the lips, tongue, and cheeks. Biopsy is the method of diagnosis. If the specimen shows a premalignant lesion, the affected area should be removed. If the report states that the patch on the membrane is heaped-up keratin, no surgery is necessary. It can be covered with a denture.

The foregoing brief review of oral manifestations of systemic diseases indicates how important it is for the dentist to be able to recognize such conditions. Only when he is completely familiar with them can he make an appropriate diagnosis and adapt his procedures to the situations he meets.

This review has also indicated that a careful roentgenographic examination should be accomplished in connection with an inquiry into the patient's medical

history. Several studies have shown that a very large percentage of edentulous patients have areas of radiolucency, root fragments, foreign bodies, and impacted teeth. Other diagnostic factors from roentgenographic interpretations include: decreased or increased density of the bone, bone loss, spiny ridges, nutrient canals, trabecular formations, and anatomic landmarks. The roentgenograms can also be an aid to clinical examination to determine the presence of malignancies.

The clinical examination is both visual and digital. Two very important questions should be kept in mind at this time, and their importance cannot be overstressed. (1) Is corrective surgery necessary prior to the impression? (2) What impression technique is most indicated by the characteristics of the mouth?

The conditions of interest to us from the surgical standpoint are low muscle and frenal attachments, epulis fissuratum, tuberosity undercuts, generalized undercuts, inadequate space between retromolar pad and tuberosity, hyperplastic tissue, spiny ridges, torus palatinus, and torus lingualis.

Low muscle and frenal attachments should be surgically corrected if satisfactory dentures cannot be fabricated because of their interference. Several accepted procedures have been used.

An epulis fissuratum can be very annoying in fabricating dentures, and it is a source of irritation to the wearer. Growths of this type should be removed, and the affected area allowed to heal prior to making the impression. A small epulis fissuratum can be removed at the time of denture insertion.

Tuberosity undercuts may inhibit the proper retention or insertion of complete dentures. It is not necessary to remove undercuts from both sides. The denture can be inserted and worn satisfactorily by removing the undercuts from one tuberosity. Other undercuts should be removed so that the complete denture can be inserted and worn with comfort. Excessive trimming, which results in loss of cortical bone, is not recommended.

Inadequate space between the tuberosity and retromolar pad can be corrected by removing some of the vertical length of the tuberosity. Contraindication for this procedure is a tuberosity with a large maxillary sinus which has a minimum osseous covering. Again we must be careful to conserve cortical bone.

Hyperplastic tissue can be utilized with proper impression procedures. Excessive hyperplastic tissue can be removed if enough tissue remains over the supporting bone to protect it. We must remember that hyperplastic tissue is better than none at all.

Spiny ridges are a continual source of discomfort. They can be corrected by surgical removal, or by providing adequate relief in the impression procedure to compensate for their presence.

A torus palatinus can be relieved in the complete denture as long as it is not the large pedicle type, or is not so large that it encroaches on tongue space. The latter condition would, of course, result in discomfort and poor phonetics.

A torus lingualis can be removed if it interferes with retention and causes discomfort. Usually, adequate relief over the tori is satisfactory.

CHOICE OF IMPRESSION METHOD

The second of the two important questions is the impression method to be used. The qualities we look for in the base area of dentures are retention, stability, and physiologic compatibility with the supporting tissues. To obtain these qualities, we use two main types of impressions: the controlled-pressure and the nonpressure type. The first of these is characterized by the use of a snug tray. This type of impression results in a tighter fit due to a peripheral seal and closer adaptation to the supporting structure. The nonpressure type is taken in a loose-fitting tray and with free-flowing material. This type of impression registers tissues at rest, and it will not be as well extended or fit as closely to the supporting tissues as the controlled-pressure type. The diagnosis, then, should determine whether the mouth possesses characteristics which favor retention and stability, or whether it lacks these qualities. If the mouth conditions favor retention and stability, the nonpressure type of impression is indicated. Tissues will be at rest with a minimum of tissue distortion. If the mouth conditions are not favorable to retention and stability, the controlled-pressure technique is indicated to achieve maximum extension and close adaptation to the supporting tissues, thus resulting in adequate retention and stability.

What are the qualities we look for which are favorable to the use of nonpressure technique? They are: (1) A large tissue area for a large bearing area for the denture base. (2) Large square ridges. This condition provides large bracing areas which are essential for good stability. (3) Uniform resiliency of the supporting structures. When this quality is present, hard areas will not create fulcrums which cause soreness and abnormal movements of the denture under function. (4) A Class 1 or 2 soft palate in the maxillary arch. This permits the design of a normal post dam. (5) A mandibular arch presenting well-developed large, resilient retromolar pads; a broad buccal shelf with loose border tissues; and a clearly-defined and well-developed lingual sulcus.

What are the qualities, unfavorable for retention and stability, which indicate the use of controlled or positive-pressure impression technique? They are: (1) Small mouths with little denture-bearing area. (2) V-shaped ridges. They offer little or no bracing against lateral stresses of the denture. (3) Unequal resiliency of tissues. Such a condition will cause multiple fulcrums. The controlled-pressure technique allows better control of equalization of pressure. (4) A maxillary arch with a short, sharply descending, soft palate (Class 3). In this case the post dam is critical, and added retention is necessary. (5) Mandibular arches with taut border tissues. Such arches limit the border extension. (6) Mandibular arches with small, shallow, lingual sulcus, high floating sublingual glands, and mylohyoid muscle. These tissues can be displaced with a controlled-pressure impression to increase stability and retention.

To summarize this point, we use a nonpressure technique in a large normal mouth with good ridges, where we feel we can get adequate retention and stability, and still have a denture base physiologically compatible with the supporting tissues. If we have a small mouth and poor ridges where added stability and retention

are needed, we use the controlled-pressure technique to gain maximum coverage and close adaptation.

III. CONDITIONS INVOLVING IMMEDIATE DENTURES

The diagnosis of Class 3 oral conditions, those which call for immediate dentures, presents varied problems, namely: (1) the patient's mental attitude, (2) his medical history, (3) the condition of the remaining teeth and their supporting structures, and (4) preliminary extractions.

Patients often, because of vanity, do not want to be without teeth for any length of time. Many keep it a secret from their immediate families. A large number of patients must appear in public life every day, and an edentulous mouth would be a handicap. Others, especially women, are very sensitive, even when alone, to the esthetics of the oral cavity. Women have fainted when looking at themselves without teeth, in a mirror.

The medical history again is of prime importance and should be reviewed before attempting any surgery or treatment. For example, a cardiac condition may limit the number of teeth that can be extracted at one time.

The condition of the remaining teeth and supporting structures may influence treatment. Immediate dentures should not be made over ridges with chronic infection. An excessive loss of supporting bone of the remaining teeth may indicate the need for a healing period before the insertion of the denture.

The preliminary extractions should be decided upon at the time of the patient's first visit. Surgical procedure should include soft tissue and adverse bone contour corrections. Root fragments and foreign bodies should also be removed.

IV. CONDITIONS INVOLVING EXISTING FAULTY DENTURES

The reasons for denture complaints fall into three classes: (1) mental attitude, (2) faulty mechanics, and (3) medical reasons.

Patients often come to the dentist with complaints about dentures that, in their reasoning, are inadequate. Many of these patients are probably not acquainted with the shortcomings of complete dentures as compared with natural dentitions. They must be carefully instructed in the use and care of the dentures. They must realize that complete artificial dentures are only approximately 30 per cent as efficient as a complete natural dentition. They must change their eating habits to meet the new situation. To bring about such changes, we must explain to the patient that the soft supporting tissues were not intended to support dentures, and that overstimulation of these tissues will result in pain, loss of structure, and the need for periodic refitting of the prosthesis. Many patients have mental attitudes which are not conducive to good denture prognosis. All problems involving their mental attitudes should be discussed with them.

The patient's medical history may be a clue to the cause of denture complaints, for many systemic diseases manifest themselves in the mouth.

Faulty mechanics, however, probably account for the greatest number of denture failures, and the following should be checked: (1) faulty base areas, (2)

physiologic changes, (3) processing errors, (4) faulty vertical dimension, (5) faulty occlusion, (6) faulty polished surfaces, and (7) faults in gross construction.

Underextension of the mandibular denture is the most common shortcoming of base areas. It may be due to an improper impression technique, or overtrimming by the laboratory technician, or lack of space between the tuberosity and the retromolar pad. Thin gold castings can be made to get adequate extension in this area.

The maxillary denture is often underextended in the post dam area because the relief and post dam have not been carefully planned to meet the individual patient's need.

Small projections of base material cause localized abrasion and soreness. Such projections result from artifacts in the stone cast. Poor separating media and careless technique often cause distortion of the base area and develop a surface not compatible with the supporting tissue.

Physiologic changes in the supporting tissues and a lack of periodical servicing often cause a denture failure. The supporting structures may have changed a great deal, because of radical surgery and consequent loss of cortical bone, or because of a previous history of periodontal disease, or a systemic disease affecting the alveolar bone. The patients usually complain of looseness, food under the denture, and multiple areas of soreness.

Processing errors are many. If the operator is not very careful in packing the dentures, he invites a whole series of errors. Overpacking may increase the vertical dimension, or cause a movement of the teeth, or cause the fracture of porcelain teeth. Underpacking may result in an inferior, porous base material that has a short life and does not present the qualities we expect in denture bases. Even if the utmost care is taken in processing, the dimensional changes that are inherent in the material cause us concern, and require additional procedures to realize a successful prosthesis.

Processing errors can be recognized by remounting the dentures on an articulator after it is processed, and by carefully examining the denture base, both while it is on the cast and after it is polished.

Faulty vertical dimension is a certain cause for denture failure. If at any time adequate free-way space is not established, or if the vertical dimension of occlusion is open beyond the physiologic rest position, a denture failure follows. The patient usually complains of general soreness, looseness, and a tired feeling of the face. We should check the vertical dimensions carefully, using one or perhaps several of the accepted methods of determining the correct registrations.

Faulty occlusion is another common cause for denture failure. The dimensional change of the base material during processing is exhibited in the occlusal pattern as well as the vertical dimension. We should correct errors in occlusion by making a laboratory remount. Occlusal errors cannot be corrected in the mouth with any degree of success; so it is wise to obtain new records from the patient's mouth, and use these in remounting. Patients have many and varied complaints when the occlusion is not in harmony with the rest of the masticatory apparatus.

Polished surfaces of dentures are often taken for granted, yet they may be the cause of a number of difficulties. Patients may complain about difficulties in speech, about lack of stability of the mandibular denture, or inadequate tongue space, or packing of food on the buccal portion of the mandibular denture, or irritation by the denture periphery. Consequently, we should evaluate the necessity for rugae, for contours that may affect phonetics, and for those that affect retention and stability. Rugae often help patients orient their tongue positions. Slight variations in the palatal contour may improve the patient's phonetics. The size and shape of the polished denture borders may be a deciding factor in achieving maximum retention and stability. The shape of the polished surfaces against the tongue may be a dislodging factor.

Faults in gross construction are generally seen in improper flanges, poor tooth-ridge relationship, incorrect vertical tooth-ridge relationship, and large food tables. The patients complain of poor retention, general discomfort, and inability to masticate well.

SUMMARY

There are four major classes of oral conditions which the prosthodontist will meet in patients who may require complete dentures. Those conditions involve: (1) full-mouth extractions; (2) edentulous mouths; (3) immediate dentures; and (4) faulty dentures.

Any diagnosis of the special needs of each patient should be based upon the totality of patient history, patient condition, and patient need as it develops.

The most common causes for full-mouth extraction are: (1) caries, (2) esthetic problems, (3) periapical infection, (4) periodontal disease, (5) malocclusion, and (6) injury.

The edentulous patient presents a different problem. Before an impression is made, a medical history should be taken and a clinical and roentgenographic examination accomplished. It should then be decided whether corrective surgery is necessary, and, following that, what impression technique is indicated. The two techniques most often used are the nonpressure and the controlled-pressure impression. Generally, we use a nonpressure impression in large normal mouths with good ridges where we feel we can get adequate retention and stability. If the patient has a small mouth and poor ridges where added stability and retention are needed, we should use the controlled-pressure impression.

Immediate denture diagnosis requires consideration of four points: (1) the patient's mental attitude, (2) his medical history, (3) the condition of remaining teeth and supporting structures, and (4) preliminary extraction.

Diagnosis of faulty dentures is a problem of mental attitude, faulty mechanics, and medical background.

Let us put our diagnostic procedures, then, on a reasonable, practical basis, considering each patient carefully in a suitable manner, observing only those diagnostic aids that are of importance at any particular stage of treatment, and making further diagnostic decisions as they are needed at each step in the construction of complete dentures.

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PERIPHERAL CONTROL WITH ALGINATE FULL DENTURE IMPRESSIONS

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IMPRESSION TECHNIQUES for complete dentures branch into many avenues of thought. They are based on the operator's interpretation of anatomy, histology, and physics applied to and limited by available materials.

If past and present techniques are examined, advantages and disadvantages will be found in all. When a particular advantage is introduced, often a disadvantage is introduced at the same time. All techniques are compromises to some extent. The general aim is maximum retention and stability with no damage to the supporting tissues. In the light of our present knowledge, it is impossible to accomplish, inasmuch as resorption does occur under dentures and, to some extent, is accelerated by them. In accepting less than our aim, we are of necessity compromising.

Investigators are constantly pouring possible explanations (for the retention of dentures) into the literature. Some are backing them up with experimental data. Boucher agrees with Wilson's suggestion that adhesion, cohesion, and atmospheric pressure are the primary retaining forces.[1,2,3] Stanitz[4] evaluates surface tension as a retaining factor. Moses[5] mentions Van der Waal forces and optical contact. *All of these forces, except atmospheric pressure, require close contact of the involved surfaces.* This close contact is readily obtained with alginate impressions.

Many investigators believe that a thin fluid film of low surface tension is best for retention. By the use of atropine, and with dry denture bases, Campbell[6] demonstrated greater retention without an apparent fluid film experimentally. Like the blind men who attempted to describe an elephant after feeling but one part of the animal, it is probable that these observers are each partly right.

Skinner[7] showed experimentally that retention depends on close adaptation to the tissue and is proportionate to the area covered. He showed that a posterior palatal seal and a peripheral seal add to the retention, and that a thick fluid film detracts from it. For purposes of retention, it seems logical to cover as much area as the anatomy of the mouth will permit without damage, and to use relief sparingly to compensate for variations in the thickness of the supporting tissue, and to prevent interference with the nerve and blood supply. If these principles are followed,

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the snowshoe effect of a large base will give better support, and the flange extension better stability.

Recording the ridge vault area at rest seems desirable, because the denture will be at rest most of the time.[8] If the tissues are not displaced, they will not be a displacing factor in their attempt to return to their original position. Nature cannot attempt to relieve a constant pressure by permanent resorptive changes in the underlying bone, if this pressure is not introduced. Recording tissue at rest, theoretically, cannot be accomplished for several reasons: The mere introduction of a tray into the mouth will cause some displacement.[8] The direction and amount of force applied while making the impression will displace tissue, even if only slightly. Inaccuracies in the impression will be added to by the amount of moisture on the tissues, and by the secretion of many mucous glands while the impression is in place. The fluid content of the tissue is not constant, so even if we were to record tissue with complete accuracy, it would not be an entirely accurate record after several days. We are also confronted with the limiting factors of our available materials. Slight changes take place in all of the available impression materials, stones, plasters, and in the denture base materials.[9,10]

Because we are faced with inaccuracies over which we have no control, it is extremely important that we do not add to these inaccuracies.

In the peripheral area, there should be a slight controlled pressure based on the anatomy of the mouth to take advantage of the additional retention made possible by peripheral seal.[11,12] This again is a compromise. The pressure on the periphery of the denture will be a displacing force equal to the amount of pressure used to displace it. While this will set up a conflict of forces to some extent, we gain more than we lose. To establish a peripheral seal, the borders of our dentures should always be in soft tissue.

In the past, many impression techniques for complete dentures in alginate and similar materials showed meticulous reproduction of the denture-bearing area, but they seemed to be lacking in peripheral control.[13,14] Peripheral control and a meticulous reproduction of the ridge vault area at rest can be obtained with the following procedure.

THE MAXILLARY TRAY

A maxillary impression is made in black modeling plastic, in an oversized tray, so that the impression will be at least 5 mm. thick in the ridge vault area. This is necessary for strength (Fig. 1). The preliminary impression is removed from the metal tray. The borders are trimmed so they will be from 2 to 3 mm. short of the mucobuccal fold. The flange is thinned so that it will be the approximate thickness of the periphery (Fig. 2).

Low-fusing stick modeling plastic is added to a small section of the reduced periphery. The impression is inserted in the mouth, and this section is muscle trimmed. This procedure is repeated until the borders are formed. A narrow opening should be allowed for the labial frenum. The function of the labial frenum is similar to that of a ligament in that it limits the movement of the lip; therefore, it is not necessary to allow much space on either side of it.

The labial flange (the border from the labial to the buccal frenum) is developed so that there is a slight positive pressure on the mucobuccal fold in this region. The thickness of the labial flange is determined by the amount of tissue lost through resorption. The buccal frenum is in close relation with the caninus muscle.

Fig. 1.—Maxillary and mandibular preliminary impressions are made in black modeling plastic in an oversized tray so that the impression will be at least 5 mm. thick in the ridge vault area, for necessary strength.

Fig. 2.—The preliminary impressions are removed from the trays. The borders are trimmed so that they will be from 2 to 3 mm. short of the mucobuccal fold. The flanges are thinned to the approximate thickness of the finished borders.

Since this is a muscle of expression, part of its movement is controlled by other muscles of expression, resulting in some horizontal movement in the buccal frenum. For this reason, it is advisable to allow more freedom anteroposteriorly than was allowed for the labial frenum. The buccal flange of the impression extends posteriorly from the notch produced by the buccal frenum. The mucobuccal

fold in this region overlies part of the buccinator muscle, and its extent is controlled by this muscle. The thickness of the border in this area is controlled by the amount of tissue lost through resorption, and, in the distal aspect, by the movements of the ramus of the mandible. It is well to request the patient to move the mandible laterally and protrusively to make sure that the impression does not interfere with these functions. The distal extent of the impression at this stage of development should be extended beyond the vibrating line.

THE MANDIBULAR TRAY

The mandibular impression is made in black modeling plastic in an oversized tray (Fig. 1). It should be at least 5 mm. thick in the ridge area. It is removed from the tray and is reinforced with a heavy piece of wire. A piece of coat hanger is about right for the purpose. It is further reinforced on top of this wire with low-fusing modeling plastic, and a handle is formed.

Fig. 3.—The borders are muscle trimmed, a small section at a time, with low-fusing modeling plastic tracing sticks.

The borders are cut 2 or 3 mm. short of the mucobuccal fold (Fig. 2). A small section at a time is muscle trimmed with low-fusing modeling plastic tracing sticks (Fig. 3). The labial frenum, labial arch, and buccal frenum in the lower jaw are very similar to those in the upper, and the labial flange muscle trim should be handled in a similar manner. There is no muscle in close contact with the labial frenum, and the triangularis muscle (a muscle of expression) is in close contact with the buccal frenum.

The buccal flange region extends distally from the notch produced for the buccal frenum. The external oblique line may be palpated on the lateral aspect of the buccal shelf of the mandible and can be used as a landmark for determining the extent of the impression in this region, although it is not always a limiting factor. It is often advisable to extend the impression over the external oblique line; however, it is seldom advisable to end the mandibular impression short of this anatomic landmark. The buccal flange usually covers 5 mm. or more of the buccinator muscle in this region. Since the fibers of this muscle run horizontally, they will not be a dislodging factor. The anterior part of the masseter muscle

pushes against the distal aspect of the buccinator when in function. It is usually necessary to reduce the lateral extent of the buccal flange sharply in this region. The retromolar pad should be covered to perfect the border seal.

The anterior lingual aspect of the border approximates the lingual frenum. Because this is part of the floor of the mouth and is attached to a freely movable tongue, it must be given more consideration than the labial frenum. The sublingual crescent is the area in the anterior aspect of the floor of the mouth covering the sublingual gland. Whether this structure should be covered or not is a controversial question. If it is covered, much greater retention is obtained. The tissue in this region is freely movable and is controlled by the movements of the tongue. If the impression is overextended in this region, it will limit the movements of the tongue. It might also cause soreness and be a displacing influence on the denture. It is felt that this region should be muscle trimmed to allow for normal movements of the tongue, but not with excessive tongue movements. For maximum retention, the sublingual crescent should be covered almost to the submaxillary caruncles. Several disadvantages have been mentioned for this procedure.[2] The possibility is that covering the submaxillary caruncles may block the secretions from the sublingual gland. I have attempted, however, to do this experimentally, but without success. I have observed a number of patients, treated by students, where the submaxillary caruncle was accidentally covered without ill effect. It is doubtful, because of the extreme range of movement in this area, that the salivary secretions could be blocked by a denture. Another disadvantage suggested is that calculus is more likely to deposit under the denture. This may be true, but if a patient is prone to deposit calculus on a denture, it is likely that some will be deposited under the denture regardless of the technique used. It will be desirable for these patients to have their dentures serviced more often.

Fig. 4.—Because of the formation of the mandible below and behind the mylohyoid ridge, there is a difference of opinion as to where the impression should be extended in this region.

The distolingual aspect of the lower impression has had various interpretations because of the anatomy of the mandible in this region (Fig. 4). Some authors recommend cutting the denture short in this region, using the mylohyoid ridge as a guide.[15] This seems undesirable. The region has been given several

names by various authors. Neil called it the lateral throat area. Edwards and Boucher called it the retromylohyoid eminence because, anatomically, it extends beyond the distal end of the mylohyoid ridge.[12] From an anatomic standpoint, the latter seems more descriptive. If the impression is extended so that the border contacts soft tissue in this region, several advantages will be obtained. Retention by atmospheric pressure will be enhanced, and the tongue will be guided over the border of the denture.[3] This region is muscle trimmed by having the patient extend the tongue to the opposite corner of the mouth. It is felt that this is the extent of normal tongue movement.

Fig. 5.—The basal seat of the muscle-trimmed trays is relieved 2 or 3 mm. The muscle-trimmed borders are left intact.

Fig. 6.—The tissue side of the trays is painted with chloroform. Cotton fibers adhere to the sticky surface to retain the alginate.

THE ALGINATE WASH

The basal seat of the muscle-trimmed tray is relieved 2 or 3 mm. (Fig. 5). It is advisable to allow a small area of the maxillary tray to remain in the region of the median suture for a stop. This stop will displace some tissue. This region, however, will be relieved later, so the displacement is of no consequence.

A small area of the tray distal to the posterior palatal seal area should not be relieved. This will prevent the alginate impression material from escaping distally.

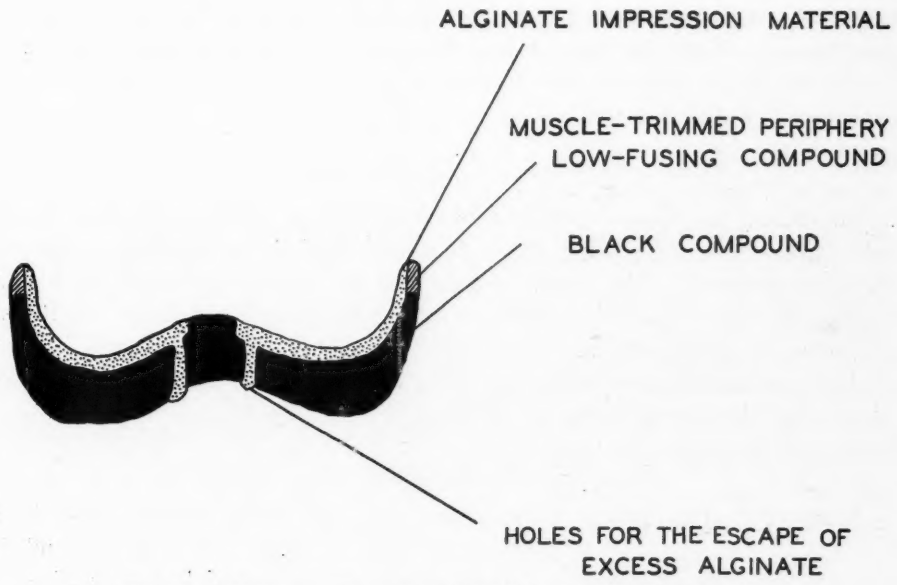

Fig. 7.—A diagrammatic cross section of the maxillary impression.

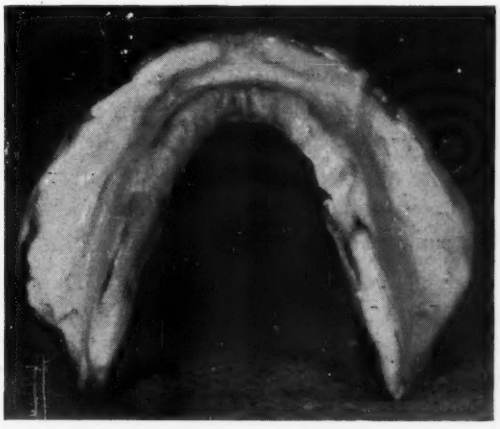

Fig. 8.—The completed mandibular impression.

The tissue sides of the trays are painted with chloroform. Because chloroform is a solvent for modeling plastic, it leaves a sticky surface to which cotton fibers will adhere to retain the alginate (Fig. 6). A hole is placed on each side of the stop in the palatal area of the maxillary tray. This is done to allow excess alginate to escape, and to prevent hydraulic pressure (Fig. 7).

A fairly thin mix of alginate is placed in the tray, and the tray is inserted in the mouth. The border tissues are manipulated to remove the alginate from the muscle-trimmed modeling plastic borders (Fig. 8). This same procedure is followed for both the maxillary and the mandibular impressions. A thin mix of alginate, although somewhat lacking in strength, will have little displacing effect on the tissues. Since the alginate is well supported, it will be sufficiently strong. The cast should be poured in the impression as soon as possible to prevent dimensional changes in the alginate.[16]

POSTERIOR PALATAL SEAL

To obtain the correct position for the posterior palatal seal, the hamular notches are located by placing a mouth mirror behind the maxillary tuberosity, with slight pressure. The notch on each side is then marked with an indelible pencil. The vibrating line is located by having the patient say "Ah." A mark is made along this imaginary line with an indelible pencil. This mark will be transferred to the alginate impression, and in turn to the cast. The depth of the seal is determined by the resilience of the tissue.

RELIEF AREAS

In all cases, the median suture (torus palatinus when present) and the incisive papilla require relief. The relief of these structures can be accomplished in several ways, depending to a certain extent on the material to be used as the denture base. If acrylic resin is to be used, perhaps the most scientific method would be to relieve the finished denture, determining the depth of the relief by functional movements of the denture by means of disclosing wax over the relief areas. The areas of the denture showing through the disclosing wax are relieved, a little at a time, until new additions of the wax are no longer completely displaced by the functional movements of the denture.[17] If a metal base is to be used, it will be necessary to add relief to the cast.

In some cases, where the mental foramina are near the crest of the ridge, or where many nutrient foramina are present, it may be necessary to give special consideration to additional relief areas.

SUMMARY

A number of theories have been offered for the retention of complete dentures. They seem to indicate that the maximum retention is obtained by close adaptation of the denture base to the tissues, and is proportional to the area covered. Experimental data shows that a border seal and a posterior palatal seal add much to the retention of dentures.

Displaced tissue has a tendency to return to its original position, and, therefore, it is a displacing factor. Because of this, and because constant pressure will accelerate resorptive bone change, a minimum of pressure should be exerted on the ridge vault areas. Although we have exerted a slight positive pressure on the border areas which might be considered as a displacing force, we have made this compromise to obtain more satisfactory retention.

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SELECTING THE ANTERIOR TOOTH MOLD

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THIS ESSAY ON tooth mold selection is presented with full knowledge of the fact that many essays have been presented in the last quarter-century on this same topic or its closely associated topic, denture esthetics. Therefore, assurance is felt that neither the presentation of a new selecting technique nor astonishing research data pertaining to one is expected. An attempt will be made to present a fairly comprehensive coverage of theories and techniques projected or used, and some personal conclusions which seem logical and of value.

The dentist is confronted with many problems and difficulties in constructing complete artificial dentures. The severity of one of these problems has been vividly pointed out by Furnas,[1] who stated, "Esthetics in full denture construction, as employed by at least 90 per cent of the men in general practice, can only be said to be conspicuous by its absence." Hooper[4] stated in discussing a paper on denture esthetics, "The skill of the dentist is . . . heavily taxed in the complete denture case," and Cohen[3] stated, "It is difficult to overcome the natural antipathy of the patient to a truthful reproduction of his own teeth where fillings and decay are apparent, when it is his desire to improve his appearance with newer, cleaner, and better-looking arrangement of teeth in a denture." Hooper[4] stated, "Whether the dental profession wishes or not, it is going to be forced to produce better dentures from the esthetic standpoint, as the public is becoming more and more educated to appreciate good-looking and well-cared-for natural teeth which, of course, makes them the more observant of artificial substitutes." Richey[5] stated, "Little has been written on denture esthetics that does not present tooth selection as one of the most important factors."

It seems easy for dentists to accept the fact that denture esthetics is a most important value desired by present-day denture patients. It is less easy for dentists to accept the fact that denture patients desire a brand of denture esthetics closely paralleling the ideal esthetic values of the third decade of life. Greater emphasis should, therefore, be placed on selecting a tooth mold more related to esthetic tastes, facial background framing, and to those characterizations of naturalness of *early* maturity rather than those of late maturity or early senility.

The operation of selecting the anterior tooth mold for the edentulous patient has always been and is now difficult, and probably will become increasingly so in future years. This difficulty is not solely one related to dentistry or to tooth selection, but universally exists whenever a selection or choice must be made.

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It matters not whether the selection is between varying tooth forms or other physical forms, colors, functions, utilities, or in the appeasement of individual human desires or demands; the problems and pressures will be constantly present to antagonize, invalidate, and engulf the selector.

The evolutionary and genetic forces and the developmental environments of man have created troublesome interplaying forces bearing on a selection decision. Differences in the abilities to recognize and appreciate esthetic values are created by man's mental capacity to differentiate and rationalize his emotions and physical states. We cannot look forward to an easy decision, to ready acceptance by the patient of the tooth mold selected, or to complete personal satisfaction in our artistry, since these human capacities, evolutionary forces, and environmental conditions are so variable and exert such powerful influence.

THE PROBLEM

It seems reasonable to grant that dentists do possess a relatively high ability to recognize and appreciate in the normal dentulous face those major physical values of the human teeth and face which contribute to cosmetic appearance and personal individuality. Apparently such ability is not so well-developed when the need is to recognize in the edentulous face those retained physical forms and relationships which indicate the tooth mold required to restore the edentulous face to pleasing appearance values. This deficiency is caused, in part, by the the fact that the edentulous face undergoes considerable physical and functional changes, which tremendously increase the difficulty of visualizing its normal values of beauty. Not only is there natural asymmetry[6] of the dentulous face, but an increased asymmetry of the edentulous face due to aging, toothlessness, and the malfunction of facial and masticatory muscles. Another possible cause of this deficiency is the varying ability of dentists properly to anticipate the modifying influence exerted on mold selection by arrangement compositions, color, spatial dimensions of the face and denture space, and by mandibular functional positions. Thus, tooth mold is not a self-sustaining value, but one greatly modified by other factors which must be correlatively evaluated. Present-day theory seems to postulate that there is little data associated with the edentulous face to indicate the tooth form most suitable for it. Therefore, it may be said that the appropriate basis of selecting the tooth form for the edentulous person is esthetic taste. Taste is defined by Hazlitt[7] as, "Nothing but sensibility to the different degrees and kinds of excellence in the work of art or nature." Thus the need in this operation is to give freedom to one's own esthetic emotion, and to apply the standards of beauty, while at the same time being conscious of the esthetic taste of the patient.

The extensive prosthodontic clinical practice of the late nineteenth and present twentieth centuries revealed that functional requirements of the anterior teeth had virtually no influence in determing their esthetic form, size, or other physical characteristics. During this period occurred an increasing recognition of the usefulness of theories which projected that the appearance values of the artificial teeth were related to, or determined by, the physical values of the face. It was more or less empirically determined that good denture appearance resulted when

the physical beauty values of the teeth, and denture bases were in harmony with, or complemental to, the physical beauty value of the facial and oral regions. The essential problem in selecting the anterior teeth, in the past as today, was to deduce the physical beauty values of the edentulous face, and to select teeth which possessed similar or harmonious physical values. The request to beautify and rejuvenate the face by artificial dentures is difficult to meet, yet should be recognized as a primary objective in prosthetic treatment. To create youth and beauty values in artificial dentures and in endentulous faces, it is necessary to know the importance of beauty and esthetics, their characteristics, the part which the teeth play, and to be conscious of the esthetic tastes of denture patients. Perhaps the following definitions will aid in understanding the interrelationship of these factors, for definitions tend to give standard basic values, and indicate the procedures most likely to yield desirable results.

DEFINITIONS

Beauty:[8]
Physical loveliness or charm to the senses.[8]
Flawlessness in form.
That which provokes immediate and disinterested pleasure in the subject that is unrelated to value or usefulness.
An attribute of the mind and the emotion and not of nature.
Objectified esthetic emotion.
That quality possessed by persons, things, and objects to create in the viewer mental images and emotions similar to those created by music and poetry.

Esthetic Emotion:[9]
The psycho-physical phenomena a person experiences—the mental images and pleasant feelings engendered upon viewing a work of art.

Art:[9]
The groups of ideas and acquisitions of skills that exist only in the mind, muscles, and nerves of living man, not the product.

A Work of Art:[9]
The product, the recorded attempt to express esthetic emotion by a suitable vehicle which others may enjoy and evaluate [such as an artificial denture].

An Artist:[9]
One who professes and practises an art in which conception and execution are governed by imagination and taste [the prosthodontist].

Technique of Production:[9]
The routine or method the artist uses to record his mental images and emotions.

DENTOFACIAL BEAUTY

The application of skill and taste to the record productions is in accordance with esthetic principles. Technique reveals some of the characteristics and measurements of beauty, i.e., size, form, proportion, balance, harmony, contrast, emphasis, unity, color, tone, style, and plot. These are the factors dentists must consider in selecting denture teeth and in creating dentofacial esthetics.

Facial and dental beauty have been extolled in the fine-arts field throughout the ages either by positive or negative characterizations. Leonardo da Vinci, a great artist and anatomist of the fifteenth century, stated,[10] "The face excels in beauty when compared with other anatomical divisions of the human being." Holmes has indicated the value of facial beauty in general and the important contribution of teeth to facial beauty by this passage: "A beautiful princess would

not exchange one of her upper central incisor teeth for the most precious jewels for her crown."

Negative characterizations of dentofacial beauty are the commonly used descriptive terms for beggars, witches, hags, thieves, etc., with whom are associated darkened, misshapened, grossly irregularly aligned teeth; arches with irregularly occurring gaps in the tooth row; lost facial dimension, with wrinkles abounding in the lips about a collapsed mouth.

Positive characterizations of dentofacial beauty are the commonly used descriptive terms for beautiful women, with whom are associated a full complement of well-shaped and pleasingly aligned teeth; a harmonious blending of tooth and complexion hues, shades, or tints; a pleasingly proportioned face, with delicate yet well-formed and defined facial features, without wrinkles, blemishes, or collapse of the mouth.

It seems logical to project that the positive qualities of dentofacial beauty comprise the ideal visualized and sought by most denture patients regardless of age. Therefore, dentists should strive to create such beauty in the tooth elements of the prosthesis and in the orofacial region by the prosthesis.

DYNAMIC BEAUTY

Beauty is present and recognized in movement, i.e., the operation of an intricate machine, the flight of airplanes or birds, the running of horses, the dancing of human beings, the gyrations of aerialists, and the tempo of music. To realize that such beauty has a commanding interest today one needs only to think of the millions who take the time to attend and observe such performances. Thus, the absence of normal rhythm and coordination in the mandibular and tongue movements during speech and comminuting functions creates a movement or sound pattern which is atypical and assaults the esthetic sense, causing great unrest in the patient and difficulties for the dentist, even though the tooth mold selected is esthetically appropriate.

POWER OF BEAUTY

Tremendous activating power is associated with beauty, which may be directed for good or evil purposes, as, for example: the creation of many monuments, sculptured statues, paintings, songs, etc., by the good influence of this power; the defeat and death of Antony, the initiation of the Trojan wars, the death of knights of old in competing for the favor of a beautiful princess, by the evil influence of this power. Similar illustrations could be projected to modern times; however, such violence is not associated with denture prosthesis.

This power can be equally as forceful in causing a patient to retain in the mouth a beautiful yet inefficient and destructive denture; or the lack of beauty can cause the ejection from the mouth of an otherwise most efficient and preventive denture. The need is to get this force working for and not against success in treatment, by satisfying the desire for facial and dental beauty, which is much more pronounced today than in ancient times or in the more recent years of the

past; yet patient gullibility for this value should not excuse deficiencies in other required values.

DENTURE BEAUTY

Artificial denture beauty is generally considered to be naturalness in the appearance of the orofacial regions, naturalness in the function of the mandible and lips, and the using of natural or esthetically appropriate tooth forms and alignment compositions and colors, especially related to what was once called late middle life. Patients are today increasingly demanding the beauty of the more youthful early middle life period to correlate and complement the artistry of several beauticians serving human beings today.

Denture art is generally a creative complex art, because form, dimension, and relations of the orofacial region and of the teeth have been completely lost by the patient. The dentist must depend upon the emotional stimulation derived from the physical characteristics of beauty and naturalness exhibited in the edentulous face to restore properly this area's physical and esthetic values by artificial substitutes. It is apparent that the bases of tooth selection are the esthetic imagination and emotion of the operator, superimposed upon the physical values of beauty and esthetic principles. The demand on the profession is not so much for a major change in prosthetic concept of denture esthetics, as it is for more application of esthetic principles and a truer expression of emotional artistry by the operator in tooth selection and in creating over-all denture esthetics.

ROUTINES, METHODS, AND CONCEPTS

The development of selecting routines parallels the increased use of the complete denture restoration, which did not become a frequent dental restoration until late in the vulcanite era of the nineteenth century. Many factors contributed to the slow development of the usefulness of denture restorations, and such factors were also intimately involved in the creation of desirable tooth forms and procedures for their selection. Such selecting techniques as were evolved revealed our dependence upon the physical characteristics of beauty and naturalness in the normal dentofacial area. This facial area is only a unit of the over-all body form, organization and function; therefore, a correlation between body, facial, and dental physical characteristics was thought to exist and to indicate the tooth form of a person. The mechanics of selecting a tooth form was the analysis and classification of the face primarily and of the body secondarily. The first step in the development of a selecting routine was the classification of human bodies and faces.

Richey[11] has projected that successful denture artists never rely upon analytical routines or stereotyped patterns of creations, but that their artistry is true artistry based on emotion, mental imagery, and stored knowledge of the human face. The advice of old masters in the fine-arts field has consistently been to forget rule and regulation, for these give an artificiality and amateurish value to the product. To assist over a period of conditioning the mind and soul to dental and facial esthetic values, certain helpful rules and regulations may be

used, but they can never supplant this personal inner force. Such rules and routine procedures as are used for selecting the tooth mold should be based on esthetic principles, so that the selector may be more rapidly conditioned emotionally to dispatch his duties to the patient and to himself, especially since this operation has assumed such increased importance since World War I.

CLASSIFICATION OF HUMAN BEINGS

The original classification of the physical and functional charactertistics of man was made by Empedocles in the fifth century B.C. He projected the doctrine that the universe was composed of four elements: fire, earth, water, and air; and since man was a microcosm, he was composed of the same elements, which were manifested in the form of body juices, such as blood, phlegm, and yellow and black biles. The various ailments and differences in man were beginning to be explained on the basis of an imbalance in these body juices.

Hippocrates classified man according to the dominance of a humor as indicated by certain combinations of physical and functional characteristics. His classification was: (1) Sanguineous for blood dominance; (2) phlegmatic for phlegm dominance; (3) choleric for the yellow bile dominance; and (4) melancholic for black bile dominance. Some of the characteristics were: large and small body stature; heavy and powerful, or small and weak muscles; slow or rapid gait or movements; face ruddy or pallid, and fine- or coarse-featured; digestion good or poor. Hippocrates termed these body characteristics "temper," or "temperaments habitus." The habitual association with the temperaments, from their inception, or certain mental, functional, and physical characteristics created the theory of temperaments or the "temperamental theory," which remained valid in dentistry until after World War I. Many new physical and functional characteristics were added, or the old order was rearranged during the time interval of its validity. It seems natural and appropriate that dentistry, at its period of need, should have turned to the temperamental theory for values indicating a choice of tooth physical forms.

The Romans apparently made the second classification of man on the basis of facial or head characteristics, as: (1) big-headed; (2) big-nosed; (3) thick-lipped; and (4) swollen-cheeked.[12] This classification apparently was intended to give a clue to the personality of the individual who possessed such facial features. This classification is of chronological interest only, but does indicate that people did then, as they do now, observe facial features and attach important values to them. Today the public uses such terms as moonface, pie face, hatchet face, horseface, dog face, monkey face, Indian face, Mongolian face, Negroid face, Nordic face, angel face, motherly face, fatherly face, brute face, and others, to classify face-outline form, profile form, and associated facial impress. Surely in selecting the tooth mold we cannot think only of outline form, but also must think of the other recognizable values which are affected by arrangement compositions, such as tooth form, size, proportion, surface contours, and facial impress.

EVOLUTION OF TECHNIQUES

In this narration of selecting techniques used or projected, it is proper to begin at the beginning and include all such techniques, even though they may have little value today. In presenting this chronological listing it is recognized that, historically, some errors may exist; yet much searching of the literature has been involved.

Technique 1.—During the ivory age and the early porcelain periods, teeth were selected, or created, mostly by dimensional measurements, with slight consideration given to face form or other qualities. This method, in modified form, and in specific application to denture space and arch size, is still a projected and used technique.

Technique 2.—The second technique was that dictated by the concept of "Correspondence and Harmony," projected by J. W. White in 1872.[13] The basis of this concept was that the temperaments called for a characteristic association of tooth form and color, and that harmony called for a corresponding proportion and size of tooth to that of the face, and a tooth color in harmony with facial complexion; that both form and color were modified to be in harmony with sex and age. White considered the detailed line values of the teeth singly, and in the over-all composition, and thought that these were modified by age and sex. The goal projected was naturalness in form, appearance, and usability of the restoration. This was perhaps the first dental concept and technique relating to the temperamental theory, and also relating to esthetic fundamentals.

Technique 3.—The third technique was the "Typal Form Concept" projected by W. R. Hall in 1887.[14] Hall states he worked out this classification in 1865, so presumably it was used previous to 1887. The basis of this classification was twofold. The major basis was the tooth's labial surface curvatures (transverse and gingival-incisal), outline form, and neck width. The minor basis was the labiolingual inclination of the upper incisors in relation to profile types of straight, convex, and concave. Hall gave the first definite measurements of typal tooth forms in 1/48 inch, and the relative size of the teeth in an arch, using the upper central incisor as the model tooth. He listed three classifications, using terms of (1) ovoid, (2) tapering, and (3) square. This classification apparently exerted little influence on practice procedure of that time. It is of interest to note that a typal form theory was projected at least a quarter-century before that of Williams.

Technique 4.—The "Temperamental Technic" of selecting tooth form should be considered the fourth technique chronologically, yet the first technique from the point of view of influence and universal acceptance. It required several years to associate and establish dental characteristics of the temperaments, and to incorporate them in manufactured tooth forms; therefore, it seems more appropriate to designate it as a specific technique only after it had attained maturity and universal usage. With each of the old temperamental classifications, appropriate tooth form, size, color, and composition had been associated by 1885, incorporated

in tooth manufacture, and requested by dentists. The basic items considered as indicative of tooth form for the edentulous patient were body and face size, form, and function, complexion, and color of hair and eyes. The choice of tooth mold was determined by analysis of the dominant and associated body characteristics.

The adoption of plastic base materials, especially vulcanite, accelerated improvements in porcelain teeth, and such represents the turning point in the need of the profession for a usable method of selecting the form, size, and other qualities of the anterior teeth, which are commonly termed the tooth mold. By 1838 teeth were being mass produced, and the tooth forms offered during the succeeding twenty-five years were conventional forms, or imitations of selected extracted teeth. During this period, a thousand or more differing forms were produced for sale, and they were selected by a "hunt and pick" method in dental depots, which could, with appropriateness, be listed as our fifth technique, yet it is not so done.

The problem of selecting the proper tooth form became acute about 1875 when vulcanite was more or less universally adopted as a base material, and manufacturers had solved many of the other problems relating to usability. Dentists began earlier to turn to the temperamental classification to ease this problem. The characteristics of the teeth, however, had received very little attention in formulating the temperament classes.

Flagg, Laycock, Hutchinson, Kingsley, and other dentists became prominent in the formulation of classifications indicating the associated character items bearing on tooth selection, such as: (1) complexion, (2) hair qualities, (3) skull and face shapes, (4) mandibular position, and (5) tooth form. After 1880, many "named sets" of temperamental teeth were presented by manufacturers, which temporarily eased the selection problem by eliminating the "hunt and pick" technique. Dentists developed individual ideas of the tooth characteristics which they wished to associate with the temperaments, so the manufacturers developed new forms and marketing procedures, and dentists used one of the several projected temperamental classifications for selecting purposes. The dental and facial characteristics of the temperamental classifications had become quite uniform and stabilized by the many publications in dental journals in the decade of 1885 to 1895. Thus, the common usage of the temperamental theory by tooth manufacturers and dentists established this theory as the basis for selecting tooth mold.

The following developments of the temperamental theory proper were directly related to its adoption by dentistry: After the Renaissance, phrenologists, physiognomists, pathologists, physiologists, ethnologists, paleontologists, artists, physicians, and finally dentists became increasingly interested in the physical, functional, mental, and esthetic values of man. Many characteristics were observed and catalogued as belonging to one temperament or another, depending upon the interest and viewpoint of the observer, such as: the geometric classification of face outline form and profile, which was projected by Madame Schimmelpeinik in 1815 for artists' use; the classification of head, face, eye, and hair form, and other physical qualities, projected by Spurzheim in 1936 for phrenologists' and physiognomists'

use; the classification of alterations in body form and function, projected by Jacque in 1878 and used by physiologists and pathologists; and the classification of the physical characteristcs relating to the face, jaw, eye, hair, and skin color as used by ethnologists and paleontologists. The dentist's problem was to correlate and supplement these various field values into a dental temperamental classification useful for selecting the tooth mold. This required a quarter-century and the efforts of many men.

Technique 5.—The fifth technique was "Berry's Biometric Ratio Method," projected in 1906.[15] Berry projected, in 1903, that the outline form of the inverted upper central incisor tooth closely approximated the outline form of the face. Therefore, the outline form of the edentulous face indicated the outline form of the anterior teeth to be chosen for a denture patient. Berry's continued investigation into the correlation between face form and tooth form resulted in the discovery that the proportions of the upper central incisor tooth had a definite proportional ratio to face proportions. The tooth was one-sixteenth the face width and one-twentieth the face length. Subsequent usage of this ratio factor proved its validity relating to tooth width and that ridge bulk frequently interfered with using the indicated length ratio. Research of M. M. House[29] substantiated Berry's one-sixteenth width ratio, but not his length ratio, as he found the one-sixteenth ratio applied to both dimensions. House projected that the common error in facial measurements did not reduce the practical usefulness of this method; however, difficulty in practical application apparently has discouraged its use except in the manufacturing procedures.

Technique 6.—The sixth technique was Clapp's "Tabular Dimension Table Method," presented around 1910.[16] This method was based on selecting tooth size from the over-all dimension of six anterior teeth arranged on the Bonwill circle and the vertical tooth space present in the patient. Outline form was based on the operator's impression of harmony in face and tooth forms. At this date, laboratories and dental depots had assumed an important place in the prosthodontic field. This tabular table method enabled the dentist to select and specify the mold of the teeth to be used by number, instead of delegating this function to the technician or depot clerk. An auxiliary of this method was illustrations of the form and size of tooth molds, which encouraged visualizing the appearance as well as knowing the dimensions. This system is still used today.

Technique 7.—The seventh technique presented was Valderrama's "Molar Tooth Basis," projected in 1913.[17] According to this method, varying measurements between combinations of cusp points indicated the size of the individual and over-all tooth measurements. There is no indication that this technique ever received clinical use, principally because no molars are present in edentulous patients. He also predicated a selection of tooth size on a one-fourth increment of the size of a Bonwill triangle, determined by measuring the edentulous mandible.

Technique 8.—The eighth technique was that projected by Cigrande in 1913.[18] This consisted of using the outline form of the fingernail to select the outline form of the upper central incisor. The size was modified to meet the require-

ments of tooth space and other relationships. This technique apparently was not used, but it does indicate the range of search for factors and body characteristics which might aid in this difficult operation.

Technique 9.—The ninth technique of selecting tooth form was "Williams' Typal Form Method," projected in 1914.[19] The projected basis of this method was Nature's uninhibited ground plan in developing human face and tooth forms. This ground plan was interpreted by the geometric pattern created by the outline form of the bony face frame. This pattern was the square, tapering, and ovoid forms. The upper central incisor tooth was considered the modal tooth of the arches. Modifying factors created by disease, development, physical forces, and racial mixtures gave adulterated forms with a prevailing dominant form, but they were not considered sufficiently significant to invalidate the theory. The theory and technique were widely accepted for many years, but some have questioned their validity in recent years.

M. M. House has projected data showing that the classification is applicable to root, crown, and occlusal form as well as face form. The frequency of occurrence of these forms has been projected by House, Wright, and other investigators.

The basic idea of harmony of face form and tooth form has been accepted as a valid determining factor of tooth form throughout the history of prosthodontic practice. It is unimportant, from a practical point of view relating to tooth form selection, whether Nature's developmental plan has or has not been discovered. It is important that the factors presented are valid in relation to selecting the best-appearing tooth form for the edentulous patient. The typal form technique is the basic and almost universally used technique today.

Technique 10.—The selection of tooth form by "Mold Guide Sample Teeth," I choose to list as the tenth technique, principally because I am uncertain of its correct location chronologically. This made the selection of form and size much easier, and since it is a method known to all today, no special treatment will be given to it.

Technique 11.—The eleventh technique was the "Wavrin Instrumental Guide Technic," projected about 1920,[20] which was based on Berry's Biometric Ratio Method, and Williams' Typal Form teeth. While the instrument was quite satisfactory, its usefulness was mostly limited to a single manufacturer's product, so apparently it has been dropped as a regular method and is not used to any extent today.

Technique 12.—The twelfth technique of selecting tooth mold was the "Maxillary Arch Outline Form," projected by Nelson in 1920.[21] This technique assumed that the arch outline form was a valid method, since it was related to the individual's anatomy, and since clinical use had proved it (in the projector's hands) a reliable method easily executed. This method is projected in one of the present-day textbooks, so presumably it is still used to some extent.

Technique 13.—The thirteenth selection technique was "Wright's Photometric Method," projected in 1936.[22] This was based on using a photograph of the

patient with natural teeth, and establishing a ratio by comparative computation of measurements of like areas of the face and photograph. The simple unknown mathematical formula could be used to select teeth or to create correct vertical dimension. Minute inaccuracies in measurements tended to diminish greatly the reliability of the technique, so it has enjoyed little usage.

Technique 14.—The fourteenth selection technique was the "Multiple Choice Method," projected by Myerson in 1937.[23] This was based on a need for a selective range in labial surface characteristics of transparent labial and mesial surfaces, varying surface color tone, and characterizations of teeth by time, wear, etc. Harmony of tooth size and shape with face size and shape was associated with this technique, which is in use today.

Technique 15.—The fifteenth selection technique was "Stein's Coordinated Size Technic," projected in 1940.[24] This was based on the coronal index of 70 to 100, commonly used in prosthetics on four model teeth representing the range of maximum frequency of use, and on the common variability in size of individual natural teeth. The index is the width per cent of the length. The variability is 0.5 mm.; model size varied from 7.2 to 8.7 mm. This is also a currently employed technique.

Technique 16.—The sixteenth selection technique was the modified "Anthropometric-Cephalic Index Method," projected by Sears in 1941.[25] This was based on the fact that the width of the upper central incisor could be determined by dividing either the transverse circumference of the head by 13 or the bi-zygomatic width by 3.3. The tooth length was in proportion to the face length. This technique has apparently received little or no general use.

Technique 17.—The seventeenth technique of selecting tooth forms was the "Frame Harmony Method," projected by The Justi Company in 1949.[26] The basis of the method is that the size and proportions of the teeth are in harmony with the general bony proportions of the skeleton. The over-all tooth size is selected by a mathematical formula, one-seventh the total dimension of the upper and lower bearing areas, with the dimensions of the individual anterior teeth correlated with a developed table of tooth dimensions to give the indicated over-all dimension. Other characteristics of tooth form are based on genetics, and the comparison of such dental qualities of a near relative. This technique is also in current use.

Technique 18.—The eighteenth selection technique was the "Bioform Technic," projected by the Dentists' Supply Company in 1950.[27] It is based on the geometric outline forms of face and teeth, the "House" classification of four basic and three combination typal forms, and three-dimensional harmony of tooth form and face form. It is associated with the tabular table and mold guide systems. This is a currently used technique.

Technique 19.—The nineteenth technique was the "Selection Indicator Instrument Method," projected by the Dentists' Supply Company, which is correlated with Williams' and House's typal form theory and the tabular table technique.[28]

Technique 20.—The twentieth selection technique was the "House Instrumental Method" of projecting typal outline and profile silhouettes onto the face by means of a telescopic projector instrument, and silhouette form plates. This was correlated with designated mold numbers and size variation.[29] It was projected by House in 1939 and by the Dentists' Supply Company in 1950. It is a currently used technique.

Technique 21.—The twenty-first technique was the "Automatic Instant Selector Guide" of the Austenal Company, projected in 1951.* This technique correlates form, size, and appearance in such a manner that a single reading only is required to select the appropriate tooth mold based on dimensions of denture space and harmony of face and tooth form. It is a currently used technique.

A brief projection of the procedure-technique favored by the author is as follows:

1. Establish the vertical dimension and retain in position the contoured occlusion contour rims.
2. Evaluate the following facial factors: (a) outline form, (b) proportions, (c) over-all size, (d) orifice size, (e) transverse-curvature values at lip and forehead levels, (f) asymmetry in form, and (g) profile type.
3. Evaluate modifying factors of age, sex, strength, lip activity, vertical denture space, patient demands.
4. Select potentially acceptable mold guide samples for testing.
5. Test sample teeth (a) extraorally and (b) intraorally, and (c) reduce choice to two or three teeth.
6. Give the patient a choice of the reduced selection.

CONCLUSIONS

No summary will be attempted, yet I shall conclude with this quotation from Nelson:[21] "No system of tooth selection yet devised will automatically bring perfection. Nothing can relieve the operator of the responsibility for cultivating the esthetic sense of fitness that will enable him to visualize a harmonious combination, or detect a discord in the relation of face and denture."

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SOME DIFFERING CONCEPTS OF DENTURE SERVICE

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THE PURPOSE of this discussion will be to challenge certain time-honored concepts with the hope of pointing out their fallacies and suggesting better ones that can be used in daily practice. As we adopt newer and better ways of thinking and doing—to that extent do we merit increased professional and public esteem.

In calling into question some of the orthodox concepts, I am not trying to be different, nor do I wish to discredit any of those who have marched in the parade of progress. At the same time, no one is so great an authority that we can afford to take his word without some degree of skepticism. Outstanding prosthodontists have contributed a great fund of information as well as a certain amount of misinformation.

As for the current contributors, we should be on guard not to fall under the spell of the enthusiasm so often shown by the sponsor of some intriguing idea, for intensity of belief is no measure of the truth, nor should we allow friendship to distort judgment, as it so easily can.

You in general practice will accept some of the newer concepts in theory today, and then tomorrow, in practice, you will do things in the same old way. In this respect general practitioners are very much like denture specialists.

Of course the situation is not quite so black as this because *some* men will accept *some* of the newer concepts, and a certain degree of progress is assured.

And so with this approach, let us hold up to question some of the time-honored ideas, and try to find some better ways of rendering denture service. Naturally, there are a few men well out in front on some of the items to be mentioned, but quite a number in the profession seem to know little and care little about the need for improvement.

To a degree, our dental schools are at fault. The professor of prosthetic dentistry in each school ordinarily becomes orthodox about how things are done. His position encourages him to hold fast to the so-called "tried-and-true" ways. This "safety first" attitude, together with the lack of adequate courses in physics (especially mechanics), makes progress in the field slower than it would otherwise be.

It was partly to overcome these difficulties that I wrote the book entitled *Principles and Technics for Complete Denture Construction.*[1] The volume is

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intended to present to the general practitioner certain information and certain basic concepts that he may not have gained in dental school or discovered for himself. In fact, no dentist should continue blindly in the attitudes and methods of his undergraduate days. He will find more pleasure and greater profit in reading books and journal articles to give him new viewpoints.

And this leads us to several concepts in denture service that are different from the ones ordinarily taught in dental schools and followed in daily practice.

INFORMATION

According to prevailing custom, denture service starts with examining the patient's mouth and making impressions. This is not the best starting place. More and more dentists now seem to be learning that both they and their patients are happier if no procedures at the dental chair are begun until the patient understands the nature of the problem and agrees to the dentist's proposed services. In short, the logical place to begin is with the education of the patient.

Especially with the first dentures, but to a degree also with subsequent ones, it is advisable to dispel false notions and replace them with realistic ones. Patients too often pick up "old wives' tales" from the neighbors and others about the impossibility of doing this or that and about the terrible ordeal in prospect. On the other hand, some patients expect too much. Both extremes can lead us into unnecessary difficulties.

But it is not only to escape difficulties that we should seek agreement with the patient. Rather, it is to assure an attitude of understanding and appreciation for dentistry in general and for the dentist in particular. Few persons have an adequate conception of the intricacies and exacting demands of modern denture work. We should take little for granted in such matters as to the patient's knowledge or expectations.

What then are some of the things that we should make clear from the beginning? Well, we should tell the patient about the use of roentgenograms, about infection in the jawbones, and the possibilities and limitations concerning facial appearance. He should also know something about how to chew with artificial dentures, how to care for them, the need for subsequent inspections, and, among other things, about which foods to avoid and which to eat.

It has been estimated that one-third of all of our dental patients have some form of systemic disease. If we classify malnutrition as a disease, the proportion is much higher. Then too, we can assume that those who wear artificial dentures are in greater danger of suffering from malnutrition than are the patients with their natural teeth. This leads us to conclude that nearly all of our artificial denture patients need advice about what they should eat.

There are both physicians and dentists who feel that diet lies outside the field of dentistry. But does it? Malnutrition that may have been a contributing cause to the loss of teeth in the first place may, if not given attention, continue to impair the stamina of whatever bony support there is left.

I am not unmindful of the fact that in California a most significant start was made by the American Academy of Applied Nutrition. From California it has

spread to other parts of the country, but on a percentage basis it has not reached nearly as many of us as it should. Every practicing dentist should keep abreast of the literature of this or some similar organization, and apply its findings in his practice.

Now some may object that all of such information, even though actually valuable to the patient, cuts into our productive time in the office. To a degree that is true, but those who have made it a part of their service feel that it is nevertheless worth while. Besides, there are ways of providing the information with little expenditure of time.

A competent office assistant can learn to tell each patient the general story, leaving only a few individual things to the dentist. There are booklets prepared by the American Dental Association, the Detroit Dental Clinic Club, and by others.[2]

PHYSICAL PREPARATION

There is a general tendency for the dentist to undertake denture service without regard to the condition of the structures that must support the dentures. We should make roentgenograms of the alveolar ridges as part of our examination. If it is discovered that the jaws have roots remaining, or infected areas in the bone, we are usually wise to refuse restorative work until the hazards are removed surgically. Also, any sharp spines or points should be smoothed. Sometimes excessive hyperplastic tissue should be removed. To make dentures on defective foundations, when these foundations can be made more serviceable, is to invite unnecessary trouble.

But surgery alone may lead to trouble unless the patient is prepared physiologically to assure the desired healing. This requires more than proper eating, although part of the treatment consists of a high-protein diet. There are three more or less unorthodox things the patient should agree to in connection with tooth extraction or surgery of the ridges:

1. Complete elimination of aspirin and sugar for at least a week before surgery, and during the healing period.

2. The taking of bone meal and vitamins—especially vitamins A and C—for at least a week before surgery, and during the healing period.

3. Rest for several days after surgery. We should require the patient's cooperation as part of the agreement before undertaking the actual construction.

Even when no surgery is indicated, we sometimes meet patients in poor physical condition where the gums are too tender to support the chewing load in comfort. An important part of our problem is to build up the stamina of the tissues. Many a dentist has carelessly acquired a dissatisfied and complaining patient, who is not only detrimental to the practice but also to the profession. It is sometimes amazing to discover how much more comfortable artificial dentures become when the supporting ridges are first put into a satisfactory condition. The proper surgical preparation of ridges in conjunction with the physiologic treatment of the patient therefore, should be a part of modern denture service.

SCHEDULING

Once the patient has been educated and his mouth prepared, the next thing to do is to convince ourselves that we should stop rushing the work through to completion.

If you send any part of the work to a dental laboratory, the surest way to have something go wrong is to demand speed. Wise laboratory operators protect themselves and the profession by requiring adequate time.

If you do your own laboratory work or have it done by your own technician, you can probably recall many a vexing moment resulting from too tight a schedule.

Then look at it from the patients' standpoint. Already too many patients think all we need to do is to stick some teeth on a base and cook the whole thing for a while. We confirm this conclusion when we make impressions, look at the trial dentures in the patient's mouth, and suddenly produce the dentures all finished. He sees us at work for him only a short while, knows we are working for other patients right along, and the whole thing looks too easy. So in general, we should take more time to complete our artificial dentures.

ESTHETICS

Although artificial dentures look better today than they did a few years ago, most of us fail to make them appear sufficiently natural and pleasing. This is less the fault of the tooth manufacturer than it is our own. There are several unorthodox things we can do that will make our artificial dentures appear more natural.

As for the forms of the anterior teeth, we make a good start by forgetting the legend that square, tapering, and ovoid teeth belong in square, tapering, and ovoid faces, respectively. Some dentists believe in this legend as firmly as they ever believed in Santa Claus, although both M. Russell Stein[3] and Walter Henry Wright[4] have disposed of the typal theory quite effectively. The evidence is available for those who care to look it up.

Perhaps the simplest and most dependable rule in this respect is that in selecting tooth forms for any patient with any type of face, we should avoid extreme outlines and extreme contours. The sets of teeth should copy natural forms that are of themselves pleasing. This will provide artificial teeth of natural appearance more consistently than trying to echo facial outlines.

In the matter of tooth size, we should also try to follow the relations found in nature. A basic fallacy has crept into dental literature to the effect that length and breadth of natural teeth can be found from the soft tissues. Anthropologists do not agree. Size of teeth is related to the bony structure, but not to the soft tissues. This fact invalidates the theory that natural tooth length can be computed from the hairline on the forehead and that the breadth can be computed from the breadth of the nares.

It follows that we should arrive at a tooth breadth from the hard tissues. A safe rule is to measure the breadth of the face at the cheek bones and divide this measurement by 3.3 to get the combined breadths of the upper six anterior teeth. For the lower six, we simply select them four-fifths as broad as the upper six. These are the proportions found in nature.

Respecting tooth color, we can assure much more natural effect than is generally produced today, and we can do this rather well with the teeth now available.

Using the upper central incisor as a starting place, we should select lateral incisors with more gray and cuspids with more yellow than we see in the sets as carded by the manufacturer. The four lower incisors should carry a high percentage of gray and the lower cuspids a high percentage of yellow. The gray, representing enamel, should be more translucent than the yellower dentine portion. These are characteristics observed in natural teeth. Selecting artificial teeth according to this rule makes them definitely more natural in appearance.

Quite properly it may be asked, "Why don't the tooth manufacturers provide us with teeth of this kind?" The answer is more simple than flattering. Actually, one manufacturer tried to market such teeth. Teeth with proper color variations, however, mounted on carding wax are so different from the ones we are accustomed to seeing that many a set was returned by the dentist with some caustic remark to the effect that the factory could not even match the colors.

Of course, some day we will come to accept and even demand the more natural distribution of color, but in the meantime we can select teeth from different sets of teeth to arrive more nearly at the desired effect. The dealer does not like to break up his stock of teeth in this manner, but he can order sets from the manufacturer already so combined. This is a place where, with very little change in our regular routine, we can improve our denture service.

Other differing concepts might be discussed to suggest what a few dentists are doing, and what all of us *could* do to improve our denture service—suggestions that pertain to immediate dentures, impression making, the selection and management of denture base plastics, treatment of tissue-bearing surfaces, and adjustments after delivering of dentures. These and other phases might be discussed with profit if there were time. But there are two items of outstanding importance that should not be omitted here. They are the scheme of prosthetic occlusion and the use of occlusal pivots. Dentistry today is pretty well divided on the scheme of prosthetic occlusion and is just beginning to make use of occlusal pivots. On both of these items we should consider departing from the orthodox viewpoints.

THE OCCLUSAL SCHEME

Today, the members of our profession use two essentially different kinds of occlusal forms to meet the edentulous situation; we have two ways of attacking the problem. One way is to start with Nature's anatomy and the other is to start with Nature's mechanics.

Thirty-five years ago it did not seem to occur to us that there are certain mechanical principles observed by Nature in the evolution of tooth forms, according to the conditions to be met. Under different conditions Nature produces different forms. For a long time, we focused our attention on human tooth forms

with little regard to related mechanics. So long as we did this, we failed to appreciate the essential difference between the situation where teeth are imbedded and held in sockets, and where teeth had to rest on the surface of a membrane. Because of this misevaluation, we were attempting to make teeth as nearly as possible in form like the ones that were created to meet a different situation. Manufacturers vied with one another to produce porcelain duplicates of the best natural forms.

At last it dawned upon some of us[5] that perhaps we were following the wrong path, especially when it became apparent that the occlusal forms most nearly like those evolved by Nature (and especially most nearly like newly erupted teeth) were the forms that necessitated the tightest denture bases. Also the increased acceptance of occlusal forms similar to those found on newly erupted teeth ushered in a period of great interest in impression making and denture refitting. A study of the literature shows this interesting development.

Better-fitting denture bases overcome, to some extent, the evil effects of the inappropriate anatomic occlusal forms. Better-fitting denture bases actually delayed the more general recognition of the virtue of specially designed occlusal forms.

The first specially designed occlusal forms were too mechanical in a sense. These early nonanatomic forms were extreme in that they ignored, to great extent, some virtues of Nature's forms. By concentration on matters of inclined plane and lever with respect to the direction of closing force and supporting value of alveolar ridges, the early designers of special forms overlooked the mechanical possibilities of the effect of cheeks and tongue. It was perhaps on this account that there was not sufficient importance attached to the buccal and lingual bulk and contours of posterior teeth.

In time, special tooth forms were developed that take into account more of the factors involved, so that the teeth look more like natural ones in form, and at the same time are in harmony with the mechanical requirements of the edentulous situation.

As already indicated, our attitudes toward posterior tooth forms are quite different among various members of the profession, and our opinions seem to be different according to geographic location. Dr. Guillermo A. Bizzozero, who is dean of the Buenos Aires Dental School in Argentina, made an extensive trip around our country last year to visit as many offices and dental schools as possible. He reports in the dental journals that the trend toward the nonanatomic school of thought and scheme of occlusion is greater in some areas than in others.

Of the most important phases in denture construction, posterior tooth occlusion is perhaps the one about which dentists differ the most. The conflict is partly emotional. There are dentists who have never made a single set of dentures with nonanatomic teeth, but condemn them in advance on the theory that "you can't improve on nature." This argument has been answered many times. Then there are those who have attempted to use nonanatomic forms with little or no idea of the special requirements for their arrangement. There are even a few who have made demonstration dentures for the purpose of proving their futility.

In mentioning this differing concept to bring it to attention for closer study, we cannot make here the point-by-point comparisons between the different occlusal schemes. This has already been done pretty well in the literature. We should remember, however, that the anatomic scheme is characterized by points or cusps that are intended to follow certain chewing paths, and to mesh with their antagonists in the various occlusions of the teeth, whereas most of the nonanatomic designs now available are intended not to mesh at all, but to glide freely in the various horizontal jaw movements.

It should be pointed out that only with special forms is it possible to isolate satisfactorily the different units of the occlusal scheme, and to manage these units separately according to their distinct functions. Only with special forms can we apply mechanical laws satisfactorily for the greatest degree of denture stability, patient comfort, and tissue preservation. Only with special forms can we permit the mandible to find its position of equilibrium in all dimensions by the use of occlusal pivots.

There are still refinements to be made in matters pertaining to the designs and materials for posterior teeth, but the general principles are becoming better understood and more generally applied, so that it becomes largely a question of the rate of our progress. Increased study and experience will lead us to more rapid progress.

OCCLUSAL PIVOTS

The purpose of the use of pivots in the molar regions is to reduce the closing pressure on the glenoid fossae and on the anterior alveolar ridges. It has been little noted in the past that, especially with artificial dentures, the occlusal load soon moves toward the anterior parts of the alveolar ridges and on the temporomandibular joints. In counteracting this tendency with occlusal pivots, it is not merely a matter of setting the opposing molars in supraocclusion, although that is part of the requirement. The need for occlusal pivots will be seen clearly when we appreciate the three detrimental conditions that result from the usual tooth arrangement and from the orthodox use of the articulator. These three conditions are:

1. Destruction of the anterior alveolar ridges. It is not uncommon to see mouths in which the ridges are hyperplastic or resorbed from the cuspid to cuspid region, while the tissues in the bicuspid and molar regions remain full and firm. This all too common condition has been described and discussed in the literature. Such destruction of the anterior ridges could have been prevented by maintaining the load in the posterior part of the mouth. The continued destruction can be prevented with the use of occlusal pivots.

2. When too great a proportion of the closing load is applied at the anterior teeth and at the condyles, the weakest part of the body of the mandible bends, causing the angle of the ramus with the body to become more obtuse. This tends to protrude the chin, shorten the interridge space in the molar regions, and make the angle formed by the opposing ridges mechanically less favorable. It produces the typical "old age" notching just in front of the angle of the mandible. This dis-

tortion could have been prevented by maintaining the load in the posterior part of the mouth. The continued bending can be prevented with the use of occlusal pivots.

3. Excessive closing pressure in the temporomandibular joint causes the condyle to be pushed deeper into its socket, thus displacing the intraarticular tissues. With some patients, this causes one or more difficulties, such as itching, buzzing sounds, aching, loss of hearing, and other symptoms of varying severity. Such lesions caused by condyle displacement could have been prevented by maintaining the load in the posterior part of the mouth. Relief of the symptoms can often be given quickly with the use of occlusal pivots.

These three evils have been with us all the time, but it is only recently that we have become aware of their great prevalence and importance. Even when we have been made aware of them, we have been inclined to assume that such changes are to be expected with advancing age, or that their prevention and treatment lies largely outside the field of dentistry.

It now becomes increasingly clear that it is our responsibility and our opportunity to treat the three evils just mentioned. This requires some readjustment of our thinking and procedures. For example, we no longer consider the dental articulator as a mechanism for reproducing exactly the various jaw relations found in the patient's head; nor should the dentures present balanced eccentric occlusions when they are first installed. It is this old concept that has been responsible sometimes for actually causing the three kinds of evils mentioned, and for perpetuating and aggravating them when they were already present. Rather, we need to use the dental articulator to anticipate the jaw relations desired, and to adjust the mechanism accordingly instead of adjusting to the relations discovered on the patient. This, of course, is quite unorthodox, even though scientific.

"Balance" or "equilibration" of the occlusion in both natural and artificial dentures can be of great benefit to the patient, but in itself is often an incomplete service. The newer concept is that equilibration of the mandible should precede equilibration of the occlusion. This more complete and more satisfactory service is made possible by the use of occlusal pivots.

SUMMARY

We have now discussed six important phases of denture service where our concepts differ. My own preferences have been indicated throughout the discussion. The presentation of this article should be considered by you as an offering to stimulate thought, discussion and experimentation. If it does this, it will afford me satisfaction quite in addition to the pleasure of meeting here with you.

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THE PROBLEM OF BUILDING SATISFACTORY DENTURES

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ARTIFICIAL DENTURES have three separate and distinct functions to perform, viz., esthetic, masticatory, and phonetic. To design dentures that will satisfactorily serve all three, and at the same time be comfortable and stable in the mouth, sometimes presents problems that tax our ingenuity, and call for the exercise of good judgment. Our present knowledge and understanding of those problems was acquired and developed down through the years, from logical concepts based on sound reasoning and verified by clinical evidence.

The latest concept presented to us is based on the assumption that the esthetic is the primary and most important factor; that artificial teeth and gums should not only be exact imitations of the natural, but that the teeth should be positioned in the vestibule between lips, cheeks, and tongue exactly as the natural teeth were. The claim is that the patient will be so happy and pleased with the appearance that all other considerations will be of minor importance, and that such things as instability, poor masticating efficiency, discomfort, and soreness will be cheerfully overlooked, tolerated, and endured. It is noted that the patient must be schooled and prepared for this before the dentures are delivered.

This concept may satisfy some patients who put appearance before and above everything else, but, for the great majority of patients, it does not seem to be logical reasoning. It is not the proper application of art to dental problems. The proper application was clearly presented to us many years ago by that great dentist, educator, artist, sculptor, and author, Dr. Norman W. Kingsley, first Dean of the New York College of Dentistry (1866 to 1868). In a lecture on "Elements of Art in the Practice of Dentistry,"[1] he makes a definite distinction between the "mechanic arts" and "fine arts." "All that contributes to the physical comfort and the utilitarian progress of mankind, we class as mechanic art; all that ministers to the aesthetic sense, furnishing food for the imagination, belongs to the fine arts." He conducted a course in "Dental Art and Mechanism." The following reference to it is illuminating and prophetic:

> A certain degree of knowledge of the highest and noblest of the manual arts of sculpture, of architecture, and of painting will be inculcated, that their refining influence may be made contributory to the advancement of the pupil, so that he may not only become master of the well known laws of mechanics but that he may become an artist, capable of inventing, originating and creating new combinations of art and mechanics.[1]

Artificial dentures are mechnical machines functioning in an anatomic environment. In cases where the esthetic and functional requirements clash, we must choose between favoring one at the expense of the other, or make compromises in the most

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favorable direction, which will lead to more satisfactory results. It takes more than fancy icing to make a good cake, and more than body streamlining to make a good motor car. A car may have great eye appeal, but if the functioning mechanism is not properly engineered and assembled, it will give endless trouble and be most unsatisfactory as a means of transportation.

Dentures, to be satisfactory, must be comfortable in the mouth, they must look right, feel right, and be efficient in both mastication and speech. Each step in the process of construction presents its own particular problems. The basic principles underlying each step are now well established, and a good working knowledge of them is a prerequisite to success. It is generally recognized that more failures result from faulty occlusal patterns than from any other single cause. The problem of establishing patterns that would function harmoniously and efficiently in the mouth was by far the most difficult one to solve.

Some thirty years ago the situation was one of utter confusion. The number of techniques advocated was bewildering. The conceptions of mandibular function were varied and contradictory. This is well depicted by an editorial entitled "What is Wrong?"[2] in the *Journal of the American Dental Association*. The failure of most techniques to produce the results claimed for them is well described by Dr. A. E. Boyce in a "Review of Full Denture Theories."[3] The problem of instrumentation was an exceedingly aggravating one, on account of the great variation in instrument designs which resulted from misinterpretation of the fundamental principles involved in the physics pertaining to prosthesis, and the modification of form and alignment of artificial teeth. This was essentially an engineering problem, and those trying to solve it were not engineers.

It was at this time that the late Rudolph Hanau came to our rescue. He pointed out that prosthetic function and anatomic function are not identical, and directed our attention to the difference between the resilient elements in the mouth and the rigid mountings in the instrument. Previous to the presentation of Hanau's findings, the entire profession was led to believe that the secret of building correctly articulated dentures in the mouth was to be found in the application of geometrized tenets, or lay in the design and construction of an instrument which reproduced jaw movements. Hanau introduced and explained the geometric considerations that apply to masticatory surface forms, and proved that reproduction of jaw movements in an instrument was not the solution of the problem, but that the instrumental movements had to be the equivalent of the anatomic movements, and that this equivalent was a result of the anatomic guidance and the "resilient and like effect" of the supporting areas of the restorations. Only in cases of sound natural dentitions, where the resilient and like effect is absent, should the instrumental movements reproduce the jaw movements. The consideration of "resilient and like effect" as a factor affecting measurements, and the development of a complete method of securing acceptable maxillomandibular registrations applicable to articulator adjustments are among Hanau's great accomplishments.

He also presented us with the Laws of Articulation and their graphic reduction to the Quint. This outstanding achievement has changed our entire views of articulation prerequisites and requirements. These laws apply to the

construction of artificial masticatory surfaces and to the repair and rearrangement of natural and artificial surfaces, wherever the establishment of balanced occlusion or its modification is desired. This was one of the finest contributions to dentistry, and constitutes the solution of that part of a problem which, for so many years, had perplexed most research workers and teachers. Their application enables us to find readily and understand the physical limitations for a choice of tooth form, tooth modification, tooth position, and alignment, thus emancipating us from contradictory claims and questionable statements. The dentist conversant with them does not have to speculate in problems of articulation; he can arrive at logical deductions.

It is remarkable that this consulting engineer should have found the solution to a problem so particularly dental and quite outside his field of academic training. While the dental profession never reciprocated by conferring upon Mr. Hanau the official recognition and honor he so richly deserved, it is paying unofficial tribute by teaching his concepts and making his instrument standard equipment in nearly every dental school in America. One uniform method of teaching should help to eliminate confusion.

TOOTH FORMS

There is still, however, much confusion in the minds of many dentists regarding all the different forms of posterior teeth advocated for artificial dentures. This is partly due to the fact that the term anatomic has been used to designate some intercusping artificial forms. When our natural posterior teeth erupt, they have cusps, they are anatomic. As the years pass and the cusps wear off, they are still anatomic. No artificial tooth is anatomic. It would appear that this term has been both misused and exploited. The occlusal forms of natural teeth are not static. During their life cycle the pattern is constantly changing, due to abrasion, until eventually the cusps may be obliterated. To accept any particular stage of wear as the ideal is accepting a pattern that is only transitory, and invites a series of questions that lead to a maze of complications. Moreover, natural dentitions and artificial dentures do not function in the same manner, and when this is not recognized, confusion regarding posterior tooth forms naturally results.

Anyone who takes time to consider the functions that artificial posterior teeth have to perform in the mouth, can readily see that the conventional intercusping forms are not suitable for prosthetic function, and is then in a better position to appraise the merits of the different forms advocated for artificial dentures. Gysi and Hanau both analyzed prosthetic occlusions in function. Both made wonderful contributions. We have their findings, as well as the clinical evidence of practical dentures made during the last fifty years, with cusps ranging from 45 degrees to zero degrees, to aid us in deciding what occlusal modifications are necessary to meet the requirements of prosthetic function.

When Gysi presented his 30 degree intercusping carvings many years ago, he frankly stated that they were merely the raw material from which we must fashion the occlusal pattern for each individual patient. He clearly recognized their limitations and shortcomings, directed our attention to them, told us where

they should not be used and why, and gave us two different patterns to help bridge the gaps. He said, "Where the inter-ridge line is inclined at less than 80 degrees to the occlusal plane it is no longer possible to get satisfactory results with them, because the tilting force on the upper buccal facets becomes too active."[4] He also said, "One of the primary requirements of denture construction is that the artificial teeth be set as nearly as possible over the ridge to insure stability and guard against any tipping or dislodging of the dentures." In Fig. 1, Gysi[4] shows four ways of setting intercusping molars over the ridge.

I, The inter-ridge line passes through the lingual third of the teeth. Here, the tilting force *K* on the buccal facets becomes active, because it falls outside the buccal border of the denture.

II, The inter-ridge line goes through the center of the teeth, and the tilting force *K* passes not far outside the denture border. This is the best position.

III, The inter-ridge line passes through the buccal third of the teeth. This produces the least dangerous tilting force, but the teeth reduce the tongue space, and the tongue being so crowded has a tendency to dislodge the mandibular denture.

IV. The teeth are set midway in the inter-ridge line as in II, but the upper molar is set too far below the ridge. This produces a great leverage on the upper denture, and the tilting force *K*, therefore, becomes greater.

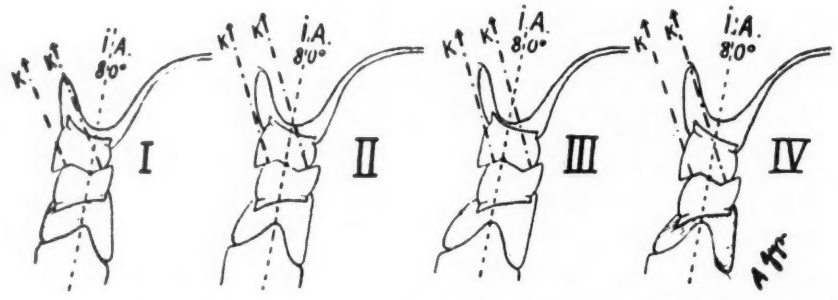

Fig. 1.—The effects of tooth position upon occlusal forces with intercusping teeth. Courtesy J.A.D.A. 16:216, 1929.

There are some very interesting features in this illustration. You will note that the inter-ridge line is 80 degrees, the limit at which Gysi says these teeth can be used successfully. This is not a bad ridge relation, and it is a very common one. You will note in *II,* the best position, that the tilting force *K* passes outside the denture border; in *III,* where the teeth are crowded in on the tongue space, it also passes outside the border and is still active; while in *IV,* the upper molar must be set right up against the ridge to avoid excessive leverage and tilting. This setting is not feasible. The upper molars are the last teeth that we position in the setup, and there are other factors of equal if not greater importance which dictate their position.

When the anterior teeth have been set for esthetics and to the incisal guidance that we select, our next step is to orientate the occlusal plane, bearing in mind that the lower posterior teeth must not be above the dorsal surface of the tongue, that the plane be located as favorably as possible to base support, and that the

compensating curve be suitable for balanced occlusion. On this basis we proceed to set the lower posterior teeth and occlude the upper teeth with them regardless of whether they are close to the ridge or not.

It is obvious that we must find some means of eliminating this tilting force on the buccal facets of the upper teeth. Intercusping posterior teeth present another problem. They have only one fixed centric occlusal position. We cannot move one tooth in or out to more favorable base support without also moving the teeth that occlude with it. How then can we use both upper and lower teeth to more favorable position when the ridge relations vary so much, and there is no flexibility in occluding the teeth?

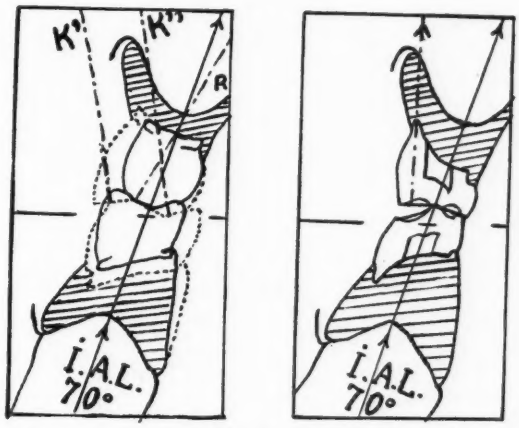

Fig. 2.—A comparison of occlusal forces developed with Gysi's "cross-bite" and French's teeth.

In Fig. 2, the inter-ridge line is 70 degrees. The drawing on the left shows how Gysi disposes of the tilting force *K*. The dotted lines show the intercusping forms with the tilting force *K* very active; the solid lines show his modified forms. You will note that he removes the upper buccal cusp, raises the lower buccal cusp, and narrows and raises the lower lingual cusp. Forces against the upper tooth are now favorably directed to base support, while against the lower, they are a little less favorable. This "cross-bite" design has limited application, and like the intercusping forms, it has no occlusal flexibility. Gysi said, "The smaller the cross section of the alveolar mandibular ridge, the narrower the masticating surface of the molars should be. For such cases, I often make all bicuspid dentures, using no molars at all, to protect the tissues under the denture from traumatic injury."[4] Why limit this protective measure to poor ridges when it can also be used to protect and preserve good ridges without impairing denture efficiency?

The drawing on the right (Fig. 2) shows French's modifications. The tilting force *K* is eliminated by making the upper buccal facets horizontal. Vertical forces pass straight up within the denture border. Removing the lower buccal cusps and converting the lower lingual cusps into a masticating surface and food

table gives lever balance to stabilize the dentures, and at the same time, it provides a narrower masticating surface to protect and conserve the residual ridge. This design also has occlusal flexibility. The upper tooth can be moved in or the lower out enabling us to set either to a more favorable ridge position. We can substitute a bicuspid for a molar, use all bicuspids, or drop a tooth without any problem of interdigitation or spacing. Posterior tooth modification is necessary, not only from a functional standpoint, but also to simplify our problem of construction. Hanau[5] expressed this in reverse when he said, "The difficulty of solving a denture problem increases with the decrease of possible modifications of existing factors. This is a generally applicable rule." The following quotations from his writings merit our serious consideration at this time since they refer specifically to the problems discussed here.

> The design and construction of a smoothly functioning denture is a purely mechanical problem which can only be solved by the correct application of sound dental engineering.
>
> It appears to me that one decided step forward will be registered in the progress of denture prosthesis, the moment we are agreed that prosthetic function is not identical with anatomical function or physiological function, but that it is a modification of the original physical function or the physiological apparatus and as such is but an accommodation to synchronous physical and physiological functions of the remaining anatomy.
>
> It should not surprise us in the least, if during the next few years many orthodox practices in denture prosthesis should entirely disappear due to a better understanding of prosthetic function.
>
> From what I have learned in your meetings in the recent past I conceive, that we progress in the right direction by rejecting the false conception that construction elements of denture prosthesis should be exact imitations of anatomical forms. The truth is that all prosthetic elements have to approach anatomical elements in form and blend with anatomical environments where visible. All this infers that a compromise in favor of physical function must govern the form of prosthetic elements where they are inconspicuous.
>
> In the past it was generally accepted that construction elements of denture prosthesis should be true imitations of anatomical form; only recently it has been recognized in various quarters that a compromise between anatomical and mechanical requirements leads to more satisfactory results.

As evidence of the misunderstanding and lack of appreciation of the differences that exist between anatomic and prosthetic functions, we have the paradox of those who say that balanced occlusion is not necessary in artificial dentures because it is not characteristic of natural dentitions; while others contend that balanced occlusion is ideal for natural dentitions because it is so helpful in artificial dentures.

COMPARISON OF NATURAL AND ARTIFICIAL DENTITIONS

Natural dentitions balance only in centric occlusion and in a limited range about centric occlusion, but not in the protrusive or lateral excursions. Protrusive and bilateral balance are not necessary on account of the method of tooth retention and the individual stability of the natural teeth which resist stress from all directions. Artificial dentures merely rest on the surface of the tissues with a film of saliva between the dentures and the mucosa. The teeth and base all function as one unit, and force exerted against any tooth in an unfavorable direction dislodges the whole denture. Dentures remain stable only when forces exerted against the teeth are directed favorably to the base support. Clinical evi-

dence has amply demonstrated that balanced occlusion contributes greatly to stability, efficiency, and comfort. This, no doubt, is what Hanau had in mind when he said prosthetic function and anatomic function are not identical, and that a compromise in favor of physical function must govern the form of prosthetic elements where they are inconspicuous. We make this compromise when we modify posterior tooth forms in such a manner as to eliminate unfavorable stresses and direct forces exerted against the teeth favorably to the base-supporting tissues.

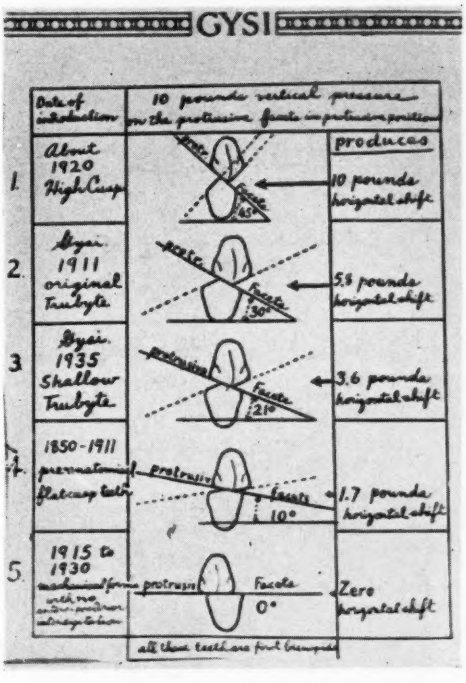

Fig. 3.—A comparison of horizontal forces developed from vertical force applied against various cuspal inclinations. (Courtesy Dentists' Supply Company.)

In Fig. 3, Gysi shows how vertical force exerted against cusp inclines is transformed into horizontal thrust. Horizontal thrust not only tends to dislodge the dentures, but also tends to destroy the alveolar ridge. Some contend that the treatment consists, not in removing the cusps, but in properly placing and coordinating them. That is what we try to do when we construct dentures. Some very satisfactory dentures have been made with intercusping teeth by men who know how to fashion an occlusal pattern that will function harmoniously in the mouth. Those dentures, however, will be satisfactory only so long as the supporting tissues remain constant, and these are the rare exceptions.

When we construct dentures, we mount the casts in centric relation at an accepted vertical dimension, set the teeth up in centric occlusion, and coordinate their function to suit the patients' needs. We then have four associated factors

(Fig. 4): (1) seating of the upper denture, (2) seating of the lower denture, (3) centric jaw relation, and (4) centric occlusion of the teeth. If our measurements on the patient are correct, this same association will be present in the mouth.

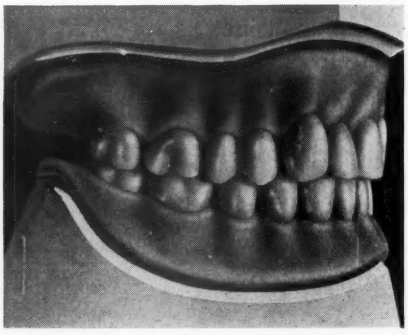

Fig. 4.—Balanced occlusion on the articulator.

Are we to assume that this association is permanent? Denture bases rest on a living tissue foundation that is always subject to change. Tissue resorption is an insidious process which creeps in, bringing opposed cusp inclines into contact and becoming progressively worse (Fig. 5). The lower denture is carried

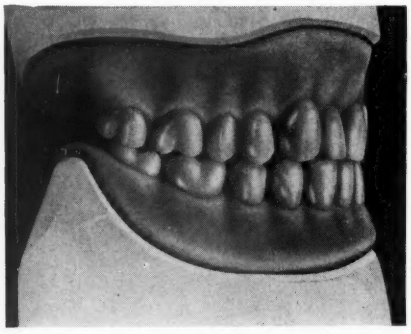

Fig. 5.—Unbalanced occlusion resulting from the loss of vertical dimension which develops with tissue resorption.

further upward and forward. The jaws remain in centric relation and the bases remain seated, but the teeth do not contact in centric occlusion. Opposing cusp inclines generate horizontal stresses which cause more resorption and further closure. This occurs in many patients long before relining is necessary to re-establish the vertical dimension or base adaptation. Hanau expressed it very tersely in the following words: "Tissue resorption under dentures is apparently inevitable. The beginning of tissue resorption means the beginning of cusp interference and the vicious cycle has a fair start."[5] We cannot prevent tissue resorp-

tion; there are so many causes over which we have no control, but we can prevent the entry of horizontal stresses by merely removing the cusps that generate them (Fig. 6), and at the same time accommodate a reasonable amount of extra-vertical closure, thus enabling patients to wear dentures with more stability, efficiency, and comfort right up to the time that relining may be necessary. This has been

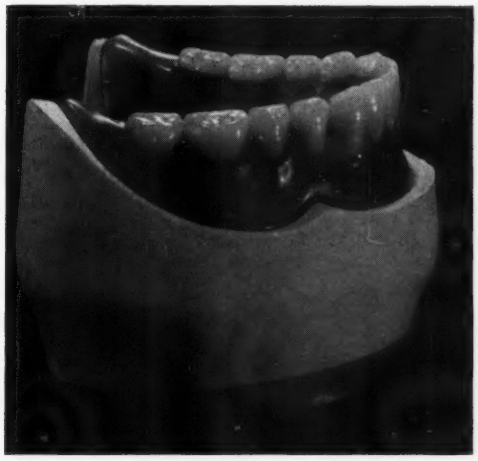

Fig. 6.—The buccal cusps have been removed from French's lower posterior teeth.

amply demonstrated by clinical evidence. You have no doubt heard the statement made or seen advertisements claiming that cusps are necessary to hold the mandible back in position. It is interesting to note that we never hear or see it, since it has been generally recognized that contact relations of the teeth are only momentary and occasional, as in the acts of masticating or swallowing, and that the mandible is suspended in a muscular sling, and its rest position a constant factor with or without teeth. Ridiculous statements and claims of this nature only tend to confuse the issue and retard progress.

The clinical evidence of practical dentures made during the last fifty years presents much food for thought when thinking over present-day problems. In the days of gum section blocks, with their shallow knob-like cusps and narrow occlusal surfaces, there were few complaints of instability and fewer calls for relining or remaking, as the ridges seemed to stand up better. Perhaps life was more simple then and patients were more rugged, but a few years later, when the floating condyle theory was advanced, viz., that the inclined planes of the teeth were the guiding factors in the movements of the mandible, and 45 degree cusps were used for better guides and mastication, the picture suddenly changed. They wrecked practically every mouth in which they were used.

Fortunately for all concerned, this concept had a short run. Like a tornado, it soon blew itself out, leaving a trail of wrecks behind. Then 30 degree cusps became popular. They were hailed as a panacea for our denture ills; but there were few adjustable instruments used, and fewer men who could fashion an

occlusal pattern that would function smoothly in the mouth, so the cry of instability and tilting became general. We had to learn how to make better impressions and to make dentures tighter, and the call for relining greatly increased. Cusp height was reduced to 20 degrees, with no perceptible change in the situation. Then came the final dive to flat plane teeth with the cusps inverted and buried.

In our search for better results we had, in the space of a few years, gone from the heights to the depths, without giving due consideration to the difference between prosthetic and anatomic function. Consideration of the difference between these two functions surely leads to the conclusion that there will be greater patient satisfaction when the occlusal surfaces are so formed that (1) forces exerted against the teeth are favorably directed to base support, (2) horizontal stresses are reduced to a minimum, (3) there is some compensation for tissue resorption, (4) they tend to conserve, not destroy the ridges (Fig. 7).

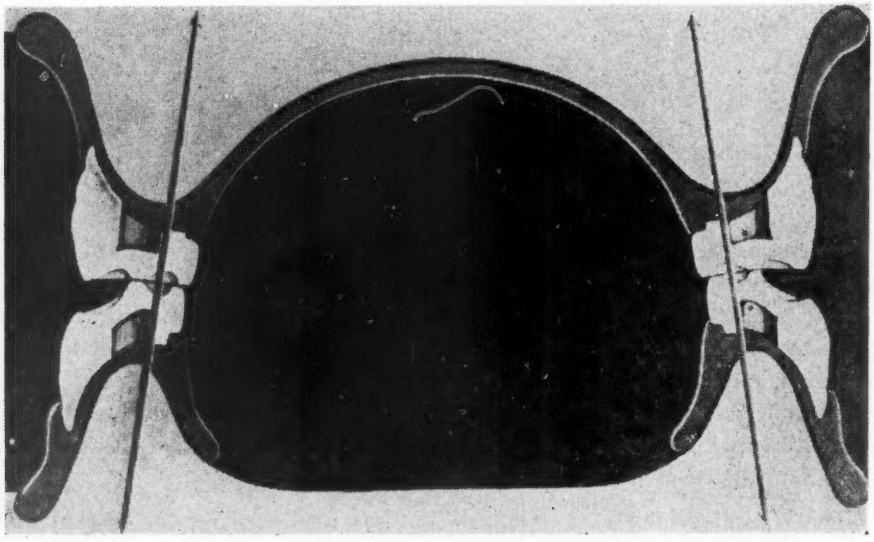

Fig. 7.—Lines of force exerted through French's posterior teeth.

If any one step in the process of denture construction is more important than another, that of establishing balanced occlusion would seem to top the list. The patient presents us with the condylar guidances; we select the incisal guidance and fashion the occlusal pattern to function harmoniously in the mouth. The three primary movements used for this purpose are the protrusive and right and left lateral movements. What incisal guidance shall we select? What is its influence? In discussing this choice, Gysi said,[4] "Let us bear in mind that flattening the incisal guide plane results in shallower facet inclinations and therefore in lessened danger of shifting of the dentures and the resulting resorption of the alveolar ridge." The dentists who still favor intercusping teeth freely admit the

advantages of a flat incisal guidance, and are now clamoring to the manufacturers for teeth with greatly reduced cusp height which can be used with a flat incisal guide plane. When we remove cusp height in the sagittal plane, to accommodate tissue resorption and prevent horizontal stresses, we must use a flat incisal guidance to facilitate protrusive balance, which is then easily obtained with a compensating curve.

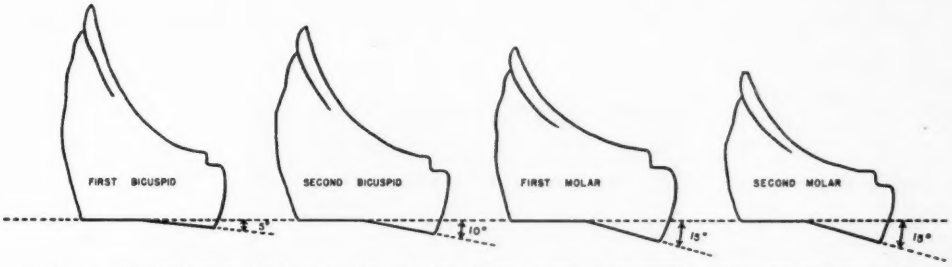

Fig. 8.—Variations in the inclination of the lingual cusps of French's upper posterior teeth.

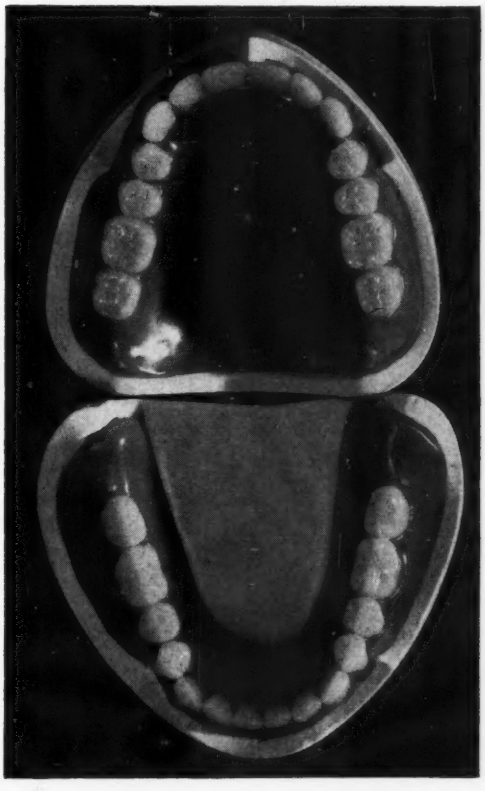

Fig. 9.—Occlusal view of French's posterior teeth.

On the right and left lateral movements, we have to consider the functional or masticatory tooth inclines on the working side, and the balancing tooth inclines on the opposite side. When the incisal guidance and Bennett movement are horizontal, the occluding buccal facets of the posterior teeth on the working side will be horizontal, and stress will be directed vertically favorable to the base support. The balancing lingual inclines of the upper molars of the opposite side will be approximately one-half the sum of the condylar inclination and incisal guidance, an average of about 15 degrees. In other words, the buccal facets of the upper posterior teeth should be horizontal, and the balancing lingual inclines of the upper

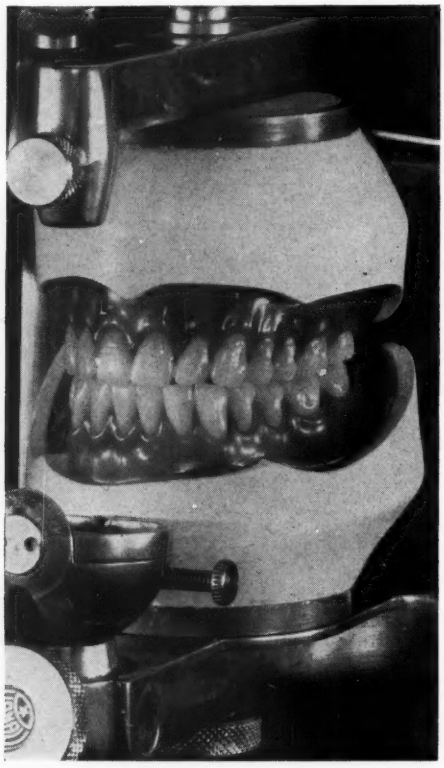

Fig. 10.—Esthetic effect of the buccal surfaces of French's posterior teeth.

molars about 15 degrees. This occlusal pattern is easy to set up to bilateral balance and requires the least amount of alteration and spot grinding. Steeper condylar inclinations are easily accommodated by merely tipping the upper molars in at the neck. Reducing the lingual incline of the upper second bicuspid to 10 degrees, and of the first bicuspid to 5 degrees, still further facilitates occluding the teeth, particularly in abnormal ridge relations (Fig. 8).

This was the basis upon which French's modified posteriors were designed. These modifications are not mere flights of fancy or haphazard guesses, they are

the expression of logical deductions gleaned from the great work of both Gysi and Hanau, as well as from years of experience with conventional intercusping forms. They are made where they are inconspicuous and externally resemble natural teeth (Figs. 9 and 10).

These modifications were designed to remove the difficulties presented by intercusping teeth and to comply with the requirements of prosthetic function, i.e., (1) to ensure denture stability, (2) to facilitate balanced articulation, (3) to eliminate, as far as possible, horizontal stresses, (4) to direct vertical forces within the denture border, (5) to compensate for tissue resorption, (6) to protect and conserve the ridges, and (7) to facilitate the problem of construction. Any dentist who sets up his own dentures and observes results over a period of time can readily decide this issue for himself. In the final analysis clinical evidence is the deciding factor.

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BIOMECHANICS AND ARTIFICIAL POSTERIOR TEETH

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A SURVEY OF the commercial dental laboratories will disclose that more than 90 per cent of the dental profession does not employ adjustable or semi-adjustable articulators. Perhaps 99 per cent does not employ face-bows. Balanced occlusion is either not attempted at all, or if a pretense at balancing complete dentures is made, it is usually performed in an arbitrary fashion.

Why, then, do the vast majority of denture-wearing patients get along fairly well? Could it be that some of the concepts which we have established as being desirable in complete denture procedures are unnecessary and a waste of time? They are certainly being defied frequently and with varying degrees of success. Success is a relative term which may have different interpretations among dentists as well as denture-wearing patients. The majority of patients do not seem to complain too audibly.

Should we not begin to examine the reasons for this apparent success? Why are there not more failures? If there were, we may be certain that greater effort would be put into the construction of complete dentures than is evidenced. This is not the first time that valuable lessons could be learned from what was believed to be inferior dentistry.

Some of us remember the supercilious manner with which the conscientious, orthodox practitioner regarded the extensive fixed bridges which the advertising dentist displayed. These, extending as a rule around an entire arch, were generally attached to four or five abutment teeth by means of gold shell crowns which were fitted very poorly to improperly prepared teeth. They were foul-smelling garbage collectors. We, of course, made beautifully polished, jewellike partial dentures. They ultimately became collectors' items. They retained their beauty because they were not worn long enough to soil. The teeth to which they were anchored were soon lost. These odoriferous fixed bridges, however, remained in their putrid surroundings for many years. From this lesson, we learned that the distribution and direction of forces were all-important factors in the retention of teeth. These principles are currently being utilized to rehabilitate mouths, using such devices as splinting, multiple abutments, internal precision attachments, and vertical application of force.[1,2,3]

THE MASTICATORY STROKE

Our concepts of mandibular movements have been altering. Studies of these movements will offer at least one clue for the reason that the majority of dentures

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are successful. In 1931, Hildebrand gave us food for thought when he demonstrated the chewing cycles of human beings and animals.[4,5]

Pleasure,[6] in 1937, and Pleasure and Friedman,[7] in 1938, demonstrated convincingly that newer concepts were needed both for artificial tooth forms and for their arrangement. They brought attention to the fact that the chewing cycles were totally different from the glides performed on an adjustable articulator. They also demonstrated that the generally accepted type of tooth arrangement tended to make the lower denture unstable. They devised a method of artificial tooth arrangement which would stabilize the lower denture during mastication. The chewing cycle was thus not only recognized, but something was done to accommodate it.

Shanahan[8] also recognized the difference "between occlusal movements of the teeth during mastication and the occlusal movements of the non-masticating excursion." He devised a system for recording the masticatory cycles in wax on the dentures.

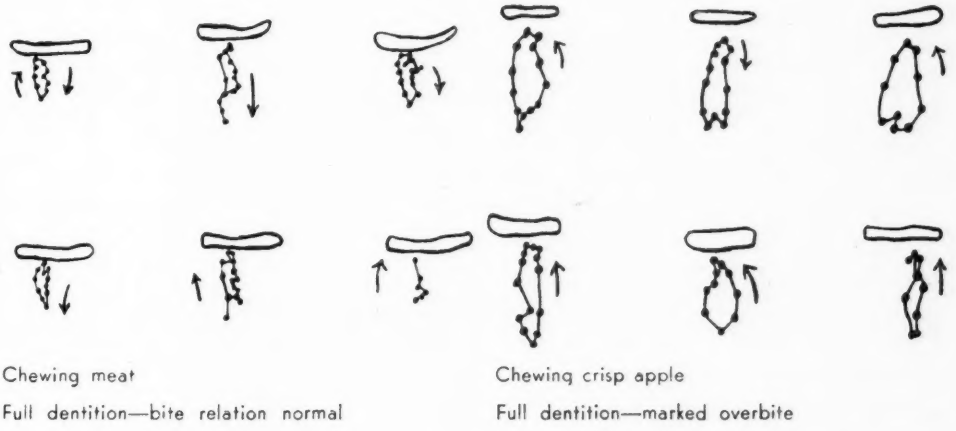


Fig. 1.—The chewing pattern is not exactly in the teardrop pattern of Hildebrand, Boswell, Kurth, and Payne. The irregular oscillations are probably caused by the neuromuscular system in an effort to achieve comfort and efficiency. (From Jankelson et al., J.A.D.A., April, 1953.)

In his prize-winning essay of 1942, Kurth,[9] demonstrated the difference between a mandibular glide and a masticatory stroke. Dentistry had been accepting the mandibular glide as being the masticatory mechanism. More recently Jankelson, Hoffman, and Henderson,[10] while agreeing with Kurth's work which was based upon movements without food being present, demonstrated some astounding facts about the masticatory stroke (Fig. 1). The chewing cycle with its teardrop pattern, as demonstrated by Hildebrand, Kurth, Boswell,[11] Payne,[12] and others (Fig. 2), takes on a variety of alterations or distortions of the pattern while food is being chewed. The nature of the food is an important factor in determining the variations in pattern of the masticatory cycle. It is likely that both the efficiency

of the teeth and their arrangement are also factors in determining the pattern of the masticatory stroke. As we shall see, the neuromuscular system participates in forming the chewing pattern.

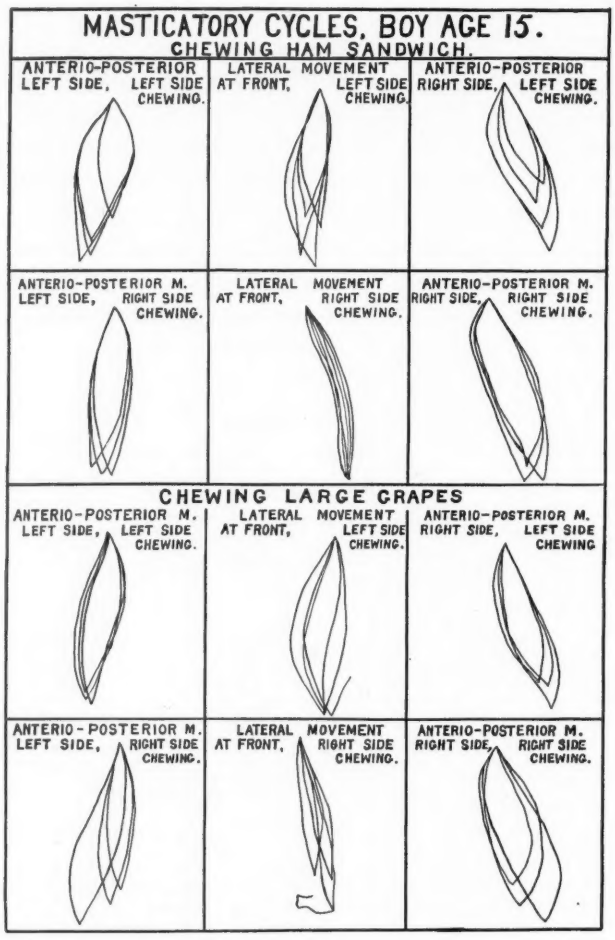

MASTICATORY CYCLES, BOY AGE 15.
CHEWING HAM SANDWICH.
ANTERIO-POSTERIOR LEFT SIDE, LEFT SIDE CHEWING.
LATERAL MOVEMENT AT FRONT, LEFT SIDE CHEWING.
ANTERIO-POSTERIOR RIGHT SIDE, LEFT SIDE CHEWING.
ANTERIO-POSTERIOR M. LEFT SIDE, RIGHT SIDE CHEWING.
LATERAL MOVEMENT AT FRONT, RIGHT SIDE CHEWING.
ANTERIO-POSTERIOR M. RIGHT SIDE, RIGHT SIDE CHEWING.
CHEWING LARGE GRAPES
ANTERIO-POSTERIOR M. LEFT SIDE, LEFT SIDE CHEWING.
LATERAL MOVEMENT AT FRONT, LEFT SIDE CHEWING.
ANTERIO-POSTERIOR M. RIGHT SIDE, LEFT SIDE CHEWING.
ANTERIO-POSTERIOR M. LEFT SIDE, RIGHT SIDE CHEWING.
LATERAL MOVEMENT AT FRONT, RIGHT SIDE CHEWING.
ANTERIO-POSTERIOR M. RIGHT SIDE, RIGHT SIDE CHEWING.

Fig. 2.—These chewing cycles are more like the teardrop patterns of other researchers. (From Boswell, J. Pros. Den., May, 1951.)

A startling revelation in Jankelson's work is the fact that while a bolus of food is being chewed and softened the chewing teeth do not meet. They meet whenever possible in centric occlusion, *after the food is swallowed*. Therefore, the type of balance which has been highly regarded for years contributes very little to efficient mastication. De Van[13] deliberately ignores the eccentric balancing movements on an adjustable articulator, but carefully obtains a balance in centric occlusion which is in centric relationship and at the exact vertical dimension. He employes a flat occlusal plane. He claims to have a high degree of success with very few adjustments, remakes, or relines. It is my belief that the standard text-

book type of tooth arrangement tends to dislodge the mandibular denture during mastication. It, therefore, becomes clearer why the average patient with the average nonbalanced dentures performs masticatory functions as well as, and in some instances better than one with so-called balanced occlusion. Despite this disturbing fact, it is the considered belief of the author that occlusal equilibration should be attempted in complete denture procedure, but not for the purpose of increasing masticatory efficiency, as we shall see.

THE NEUROMUSCULAR MECHANISM

There is another factor which is equally important when studying reasons why the simply constructed dentures become acceptable. In recent years, the neuromuscular mechanism has been receiving increased attention. To further the thought, we must consider the role of the proprioceptor and exteroceptor nerves. They play a prominent role in neuromuscular activity. "The receptor end-organs in muscles, tendons, and joints are stimulated by stretching, pressure, and movement occurring within the body and are associated with proprioceptive sensibility. Painful, tactile, thermal, pressure (from without), olfactory, visual, and auditory sensations are all exteroceptive in character, while sensations of active and passive movements and of posture are proprioceptive."[14] Proprioceptive stimuli result in readjustment of muscles and may operate at the unconscious level.

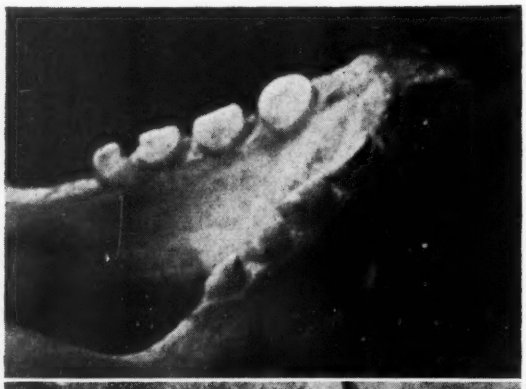
These nerves are therefore an integral part of the mechanism with which human beings attempt to achieve greater comfort during mastication. They are responsible for the various gyrations of the mandible during the masticatory stroke through food. If the food is tough or if the teeth are inefficient, the movement is different from when softer food and more efficient teeth are present in the mouth. People with natural dentitions who suffer from bruxism, clenching and grinding their teeth repeatedly, will seek positions of greater comfort. This is most likely to be where more teeth enter into occlusion. We have found that this is not necessarily in centric relation. With artificial teeth, it may be necessary to find a position where greater comfort is not only experienced because of the occlusion of more teeth but also by avoidance of painful pressure from the denture base. This is achieved by shifting the pressure to a favorable direction, moving the position of the mandible, bolus of food, or both. In extreme cases of discomfort, the denture base may even be lifted off the mucosa. The neuromuscular mechanism apparently controls the degree of pressure which is tolerable. This was obvious in Knowlton's article[15] concerning implant dentures. When the implant was first inserted the patient was able to apply far less pressure than after healing and organization of the tissues had taken place.

TESTING EFFICIENCY OF TEETH

Because of this neuromuscular mechanism, it is difficult to devise accurate tests designed to evaluate the efficiency of artificial teeth. When the patient attempts to avoid irritation or discomfort, consciously or unconsciously, he maneuvers the mandible and the bolus of food to a position where maximum comfort and effi-

ciency are achieved. It, therefore, becomes difficult to assess the efficiency of artificial teeth, since the discomfort may be so slight that the reaction to it takes place below the conscious level. There are different types and degrees of discomfort during mastication. These are not necessarily painful. The comfort of the denture base upon the mucosa depends upon several factors, among which are the condition of the underlying structures, the accuracy of the impression and the distribution as well as the direction of forces. The bolus of food is unconsciously placed in different positions, and on different teeth, to obtain the greatest advantage in comfort and efficiency. A variety of motions, directions, and degrees of pressure could take place, thus affecting the efficiency of the dentures. Among the best tests to evaluate artificial teeth was the one devised by Trapozzano and Lazzari.[16] They used a common denture base for different types of teeth. Although this was a commendable effort (it is difficult to conceive a better one), it could not be an exacting one. One marginal ridge or one cusp on the occluding surface of a tooth out of harmony could cause a type of discomfort which would alter the pattern of chewing and perhaps the efficiency.

Fig. 3



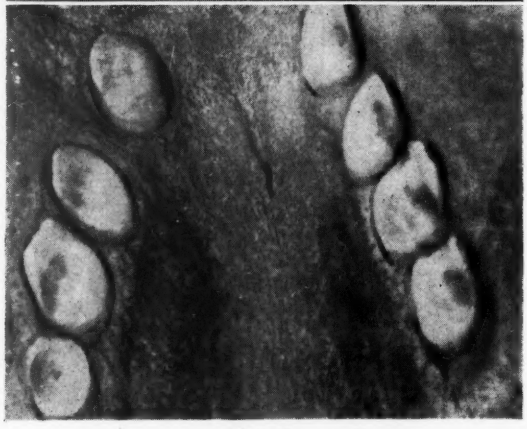


Fig. 4

Fig. 3.—The mandible of a walrus. There is similarity between these teeth and Sears' channel teeth.

Fig. 4.—The maxillary teeth of a walrus.

ADAPTATION TO ENVIRONMENT

It must also be remembered that, in the main, the story of evolution is an adaptation to an environment. Man has proved to be nature's most adaptable animal. He is constantly adapting to the ever-changing environment for which he is chiefly responsible. There are some who are not able to adapt themselves to new situations, but most people do. There have been occasions when individuals have adapted themselves to seemingly impossible conditions. We have seen dentures being worn which should, by all our standards, be intolerable. On the other hand, some dentures which we consider to be well constructed are not tolerated. It could, therefore, be concluded that with the help of the neuromuscular system and the adaptive capacity of the individual, those dentures which we have seen in the commercial dental laboratories are useful. An important factor also is the fact that occlusion is not the terminal position of the masticatory stroke.

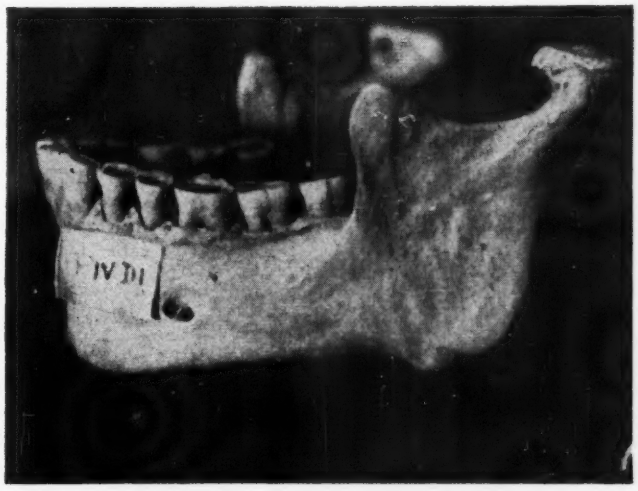


Fig. 5.—Mandible of an aboriginal. Note the flat occlusal surfaces, the sharp rims of enamel for cutting and the hollow sluiceways, the anti-Monson pitch of the posterior teeth with the exception of the third molar, which has a Monson pitch, the flat condyle resembling condyles of ruminants to accommodate gliding movements.

MECHANICAL REQUISITES FOR POSTERIOR TOOTH FORM

Sears[17] was the first proponent of an unorthodox tooth who recognized the need for a specific design for artificial posterior teeth. He was subsequently followed by others. These teeth were called, by some, mechanical or nonanatomic. As a matter of interest, I shall point out that Sears' channel teeth are duplicated in the dentition of a walrus which I have in my possession (Figs. 3 and 4). Hall's inverted cusp teeth are sometimes duplicated by the teeth of the aborigines (Fig. 5); so are Kelly's and some of the others (Figs. 6 and 7). These artificial teeth are, therefore, natural tooth forms and cannot be termed nonanatomic. In previous articles[1,2,18] it was pointed out that the newly erupted, unworn posterior

tooth had been accepted as being normal, and that this concept was at variance with the mature pattern of teeth throughout the ages.

In view of the fact that the masticatory cycle ends in an upward stroke toward centric relation, it would appear that something sharp should be wedged into the bolus of food to break it or tear it apart. A number of wedges or knives would

Fig. 6.—Kelly's Massetors. (Courtesy Dr. Kelly.)

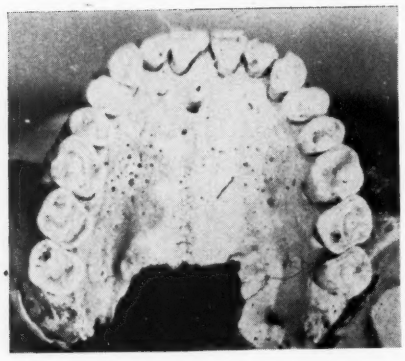


Fig. 7.—A maxilla of an aboriginal with teeth having characteristics of Kelly's Massetors.

be more desirable still. In order that the food does not gather and clog the cutting edges, escapes must be created. On the other hand, there must also be a slight interference with this escape to permit certain types of food to remain momentarily before sliding down food escapes. This interference must not be too pronounced. Once the food does reach the escape outlets, its passage should be facilitated. It would be better, then, if the final food escape were on a slope or an angle.

All these requirements are usually met by the dentitions of the aborigines. They are also met by our patients who manifest wear on their natural teeth. The buccal cusps of the lower posterior teeth and the lingual cusps of the upper teeth wear off, presenting an anti-Monson pitch (Figs. 8 and 9). Even if there is no

lateral glide in the masticatory stroke, the presence of which I always suspected, the mechanism is efficient.

Fig. 8

Fig. 9

Fig. 8.—A maxillary cast of an Eskimo woman aged 23. Note the marked wear of the teeth. Cusps are lost at an early age and are not, therefore, an evolutionary pattern designed for efficiency. (From Moses, D. Items Interest, October, 1946.)

Fig. 9.—A cast of the mandibular teeth of the same Eskimo woman as in Fig. 8. Rims of enamel cut the food, the higher lingual edge entering the bolus first. The food escapes down the slope toward the cheek. The slope of the maxillary teeth sends food lingually. (From Moses, D. Items Interest, October, 1946.)

Jankelson says, "A lateral movement of varying range often was evident at the terminal portion of the stroke." This is not evident in the sharp apex of the teardrop pattern of other workers. I am still unconvinced that a lateral glide is not included in the terminal portion of the masticatory stroke in teeth which are well worn. Worn dentitions take on the characteristics of the dentitions of

the ruminants. The latter, having much lateral gliding motion, have a broader terminal portion of the masticatory chewing cycle (Fig. 10). I believe that Hildebrand recognized this when he said, "The human movement most akin to the

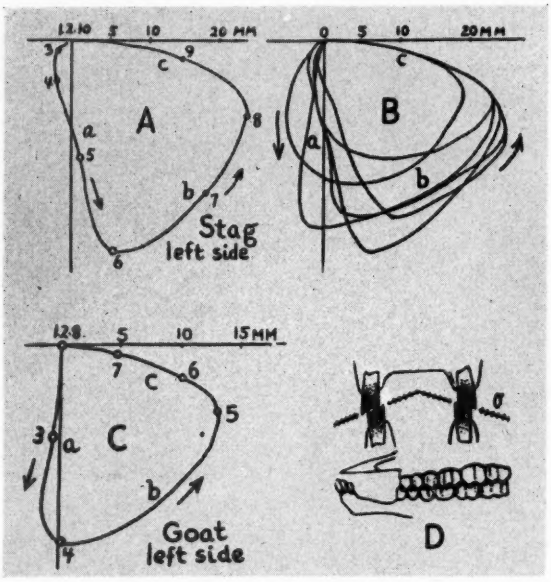


Fig. 10.—The chewing cycles of the stag and goat are influenced by the flattened surfaces and pitch of the teeth. (From G. Y. Hildebrand; Courtesy J. D. Res.)

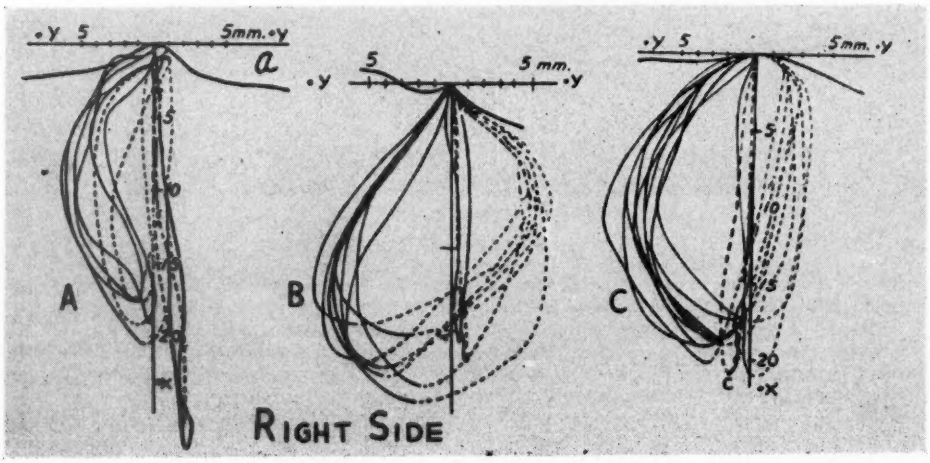


Fig. 11.—The chewing cycle *C* does not have a sharp apex which is the usual characteristic of the terminal position in the teardrop pattern. Flattened natural teeth may require a glide for greater efficiency at the terminal portion of the masticatory cycle. (From G. Y. Hildebrand; Courtesy J. D. Res.)

ruminatory one is found in a case of labidodonti (straight bite)." This patient's terminal position did not have the sharp apex usually found (Fig. 11). Having an end-to-end occlusion on the anterior teeth, I suspect that he may have had a flattened occlusal surface. Aborigines with flattened dentitions have flattened condyles (Fig. 5). This is also a characteristic of the ruminants. These are distinctly different from the rounded condyles of people who are forced to chew with a predominantly up-and-down motion. The condyles of carnivora, because they have only an up-and-down hinge action, are also rounded. The lack of a glide at the terminal position of the masticatory stroke in some individuals (thereby decreasing efficiency) is possibly compensated for by the series of minute lateral oscillations which we see in Jankelson's study, and for which he offers no explanation.

Returning to the discussion of the dentitions of aborigines, the lingual edge of the mandibular tooth, which is higher, strikes the bolus of food first, wedging itself through it. The cutting knives, which are the edges of enamel, assist in the trituration. The food escape sluiceways formed by the hollowed, softer dentine along the slope of the occlusal surface of the entire tooth, which is toward the buccal, slides food toward the cheek. In the meantime, the longer bucco-occlusal edge of the upper tooth cuts through the bolus of food first, causing the food to slide toward the palatal surface. The tongue and cheek reassemble the bolus, placing it upon the occluding surfaces of the teeth for further comminution. It becomes clearer why the aborigines have so much masticatory efficiency in coping with their food. Every factor that makes for more efficient chewing is present, along with an adequate musculature.

It follows that the posterior tooth, to be efficient, should have sharp cutting edges with an anti-Monson pitch, a term originated by Pleasure to indicate the buccolingual inclination of teeth in a direction opposite to that popularly accepted. The high-cusp teeth which some practitioners use for artificial posterior teeth may have efficient cutting edges, but fall short in other respects. Schuyler,[19] however, does not completely subscribe to the thought that convex cusps forms "are most efficient or that they materially reduce trauma." Even if the steeper cusps wedge through the food efficiently, as some tests have indicated, traumatogenic factors are indeed disturbing. The tissues under a denture base reorganize and attempt to meet the new environment. There might also be atrophy of the tissues for a variety of other reasons. This in turn causes a change in the cuspal relationship between the upper and lower dentures. Even if adjustments of the occlusion are made, they must be repeated frequently, and the carefully organized occlusions which we believe to be so necessary when cusps are used must be re-established. If this is not done, serious traumatogenic forces are created.

More frequent adjustment of occlusion is necessary with cusp teeth than with the cuspless variety. Whenever the structures under a denture base alter, the cusps of the mandibular posterior teeth begin to strike the inclined planes of the maxillary teeth during the patient's attempt to achieve centric occlusion, which is no longer in centric relationship. This results in horizontal movements of the denture bases. If adequate stops are present due to high ridges, the pressure is

applied to the slopes of these ridges. Should the patient have any degree of bruxism, the pressure becomes constant enough to cause resorption. Even the frequent closure which follows when saliva is swallowed may cause trauma if the teeth do not strike together in centric occlusion.

BRUXISM AND THE MANDIBULAR GLIDE

Bruxism is all to prevalent in human beings. It is the most overlooked subject in dentistry to-day. Perhaps it is a vestigial remnant from lower animal form. Some animals bare their teeth when disturbed. Teeth are their chief weapons for offense or defense. Human beings often clench or grind their teeth when under emotional strain. Psychologists are aware of this phenomenon, as are some dentists. Shanahan[8,20] has made mention of its frequency. The grinding patients execute mandibular gliding movements day or night, sometimes both. Periodontists find difficulty in coping with this variety of patient since the action imparts unfavorable horizontal loads on the natural dentition, injuring the periodontal membrane. This may nullify the effects of the carefully executed treatments. Prosthodontists may find excessive resorption of the ridges and tender areas. Nearly everybody at one time or another has moments of bruxism. The tensions of human society are conducive to this disease. Cusp teeth of artificial dentures which are not in perfect integration could create great havoc to ridges under conditions of bruxism.

The tendency for ridge resorption due to cuspal interferences is minimized with flattened cusps. Since tissues are constantly undergoing alterations, because nothing is static in this world, less havoc is created when there are no cusps to produce skids. I, therefore, employ the lesser evil, cuspless artificial teeth. I also attempt to arrange them in such a manner that the occluding forces will be equilibrated at the various positions in which the mandible glides. This is referred to as being balanced occlusion. Therefore, although balanced occlusion as it has been interpreted in textbooks has little effect on the efficiency of the dentures for the mastication of food, it becomes very important for the reduction of traumatogenic lesions during the mandibular glides which occur when food is absent.

Temporomandibular disturbances have been known to be caused by teeth, both natural and artificial, which are not in good relationship during the glides. The neuromuscular system guards against interferences and causes the mandible to take a circuitous route during some of the glides. This has been known to cause severe radiating pains about the temporomandibular joint.[1] Occlusal corrections have frequently overcome these conditions. Centric occlusion in centric relationship is, of course, a major necessity, and must be established along with the correct eccentric relationships.

THE ARRANGEMENT OF TEETH

Up to this point we have dealt with: (a) the importance of tooth form for efficiency during mastication and for the prevention of trauma; (b) the necessity for arranging artificial teeth to permit a balance in the gliding movements to

minimize trauma; (c) the neuromuscular system which often makes mastication possible under difficult conditions. We have also mentioned (d) that to lessen a major source of trouble artificial teeth may be so arranged that the lower denture achieves greater stability during mastication, while at the same time they maintain the advantages of an equilibrated occlusion during the mandibular glides.

The author has been arranging his teeth, except for a brief interlude of about a year, in a reverse buccolingual or anti-Monson curve since about 1939. This came about accidentally—the new laboratory technician knew of no other way to arrange teeth. After spending much chair time laboriously rearranging the teeth into the orthodox pattern, it occurred to me that perhaps this type of arrangement might stabilize lower dentures.

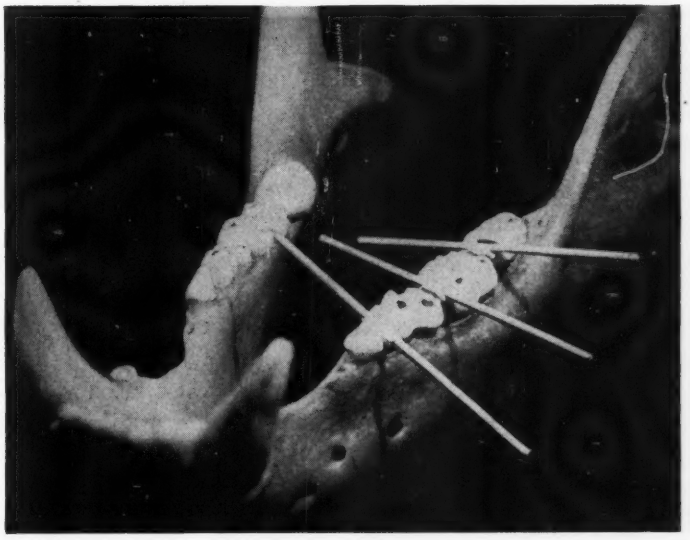


Fig. 12.—Mandible of a bear. Although only an up-and-down hinge action is possible, the arrangement of the teeth is similar to that of aborigines. This is a response to natural laws found in all animals.

At that time, I had been using a modification of Sidney S. Jaffe's method to balance artificial dentures. This method lent itself to almost any type of tooth arrangement and resembled the Meyer technique. The upper denture was finished first with an anti-Monson tooth arrangement and the esthetics established, and the lower teeth were then set to a generated path. The latter was created by rubbing the upper teeth into a softened lower compound baseplate at an established vertical dimension. The generated path was poured in stone, and the waxed up lower denture which had been laid aside was then altered to articulate with the stone path. An occlusion with an anti-Monson arrangement and a minimum of interference in the horizontal glides was thus produced.

I now employe an adjustable articulator. Thanks to Pleasure and Friedman, it is possible to create a balanced tooth articulation using the anti-Monson type of tooth arrangement, and yet employ an adjustable articulator. I found that

the Avery brothers[21] and then Pleasure had been advocating the anti-Monson arrangement for some years prior to my fortunate discovery.

The Pleasure arrangement which I am about to describe is duplicated in nature. Aborigines such as the natives of Australia (Fig. 5) and the Eskimos of Canada have similar arrangements of their natural teeth, and so have some animals (Fig. 12). This is as much of a coincidence, however, as the walrus' imitation of Sears' channel teeth. The inclinations of the teeth, incidentally, are responses to a natural law which applies to the teeth of all animals, human beings included. I was fortunate enough to uncover this law during a research project.[22]

The only reason for introducing the subject at all is to point out that many of the so-called mechanical tooth arrangements and forms may be duplicated in nature. Although we may learn something about tooth efficiency from the forms of natural and human teeth, we must devise our own schemes to achieve stability, since man is the only animal wearing artificial dentures. Sears[17] considered "the use of natural and anatomic forms for artificial dentures as an accident in dentistry." It is also an accident that the use of the tooth arrangements of the aborigines and some animals are also conducive to a balanced articulation.

THE HARDY TOOTH

A description of many types of artificial tooth forms may be obtained upon reading Sears' article. An evaluation of some of these is presented by Rapp[23] in his prize-winning essay. During an interesting panel discussion on the merits of cusp versus cuspless teeth at an American Denture Society meeting in Chicago in 1953, De Van was heard to remark about the great efficiency of Hardy's posterior teeth. They are described in an article by the originator[24] as well as by Sears.[17]

These are acrylic teeth with nonprecious metal inserts. The latter are raised approximately a millimeter above the acrylic material with a continuous wavy line throughout the tooth block. The block contains three posterior teeth and is flat. The blades of the lower teeth occlude with those of the upper in a flat plane. It is possible, by grinding, to create a variety of arrangements, although some prefer the flat arrangement. I conceived the idea of creating individual posterior teeth for each patient in accordance with his requirements and in keeping with my own concepts of tooth arrangement and form.

TECHNICAL PROCEDURE

The first step is to relate the upper and lower casts upon an adjustable articulator. A face-bow transfer is made, and an attempt is made to record centric and eccentric relationships.

ANTI-MONSON TOOTH ARRANGEMENT

Flat-cusped posterior teeth are selected for the patient. They will be of a size and type compatible with the esthetics of the patient and the operator's concepts of buccolingual widths. For instance, French's posterior teeth may be con-

sidered more suitable for one patient while Myerson's Shearcusp or Truecusp teeth may suit another patient. Anterior teeth may be either porcelain or acrylic in accordance with the wishes of the operator. The posterior teeth are now arranged using Pleasure's concepts. The bicuspids and first molars are arranged with an anti-Monson pitch while the second molar teeth are inclined in the Monson manner (Fig. 13).

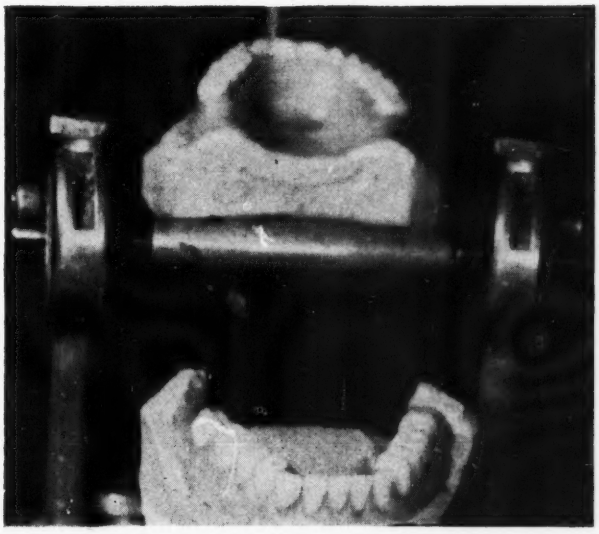


Fig. 13.—The Pleasure and Friedman concept of tooth arrangement. The posterior teeth, with the exception of the second molars, are set with an anti-Monson pitch, the second molars are set in a Monson pitch.

Thus on the lower denture, the occlusal surfaces of the bicuspids and first molar are tilted buccally while the second molar is tilted lingually. Correspondingly, the occlusal surfaces of the upper bicuspids and first molar are tilted lingually while the second molar is tilted toward the buccal. The teeth are set with a compensating curve in keeping with the condylar inclination and incisal guidance. A curve is desirable since it is the only means by which a continuous contact of the opposing teeth may be maintained throughout the anteroposterior glide. Of course, if a flat plane is used, no allowance is made for an anteroposterior glide. In the lateral glides, uniform contact is maintained on the occluding surfaces of the teeth on the working side. On the opposite (balancing) side only the second molar makes contact throughout the glide. It, along with some of the anterior teeth, helps to achieve stability of the denture during lateral mandibular glides.

Caution must be exercised not to overemphasize the pitch of the occlusal surfaces. It should rarely exceed 10 degrees. In most cases, I incline the teeth about 5 degrees. The pitch should be sufficient to direct the force between the two lower ridges. Two desirable features are achieved: (1) The direction of force seats the lower denture during mastication which is unilateral. The ar-

rangement is ideal for the masticatory stroke. (Incidentally, if the upper denture is insecure because of size or anatomic formation, the anti-Monson arrangement is contraindicated.) (2) The load is distributed on both lower ridges rather than on the buccal edge of the ridge on the working side. The latter is the usual result of the Monson type of arrangement.

The teeth are now ground wherever necessary to achieve the best possible balance in all the movements of the mandibular glide. The sulci and grooves are

Fig. 14.

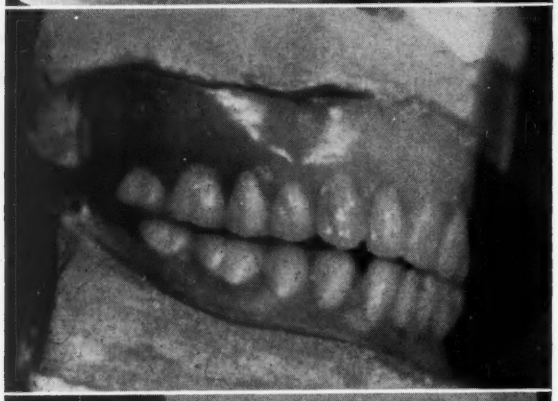


Fig. 15.

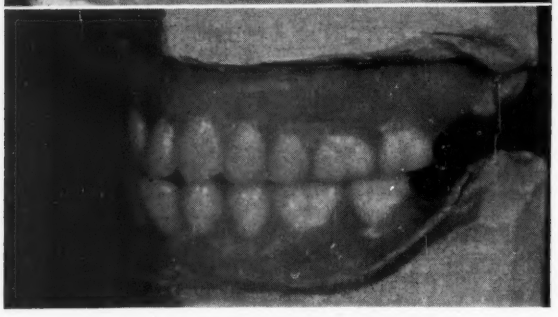


Fig. 16.

Fig. 14.—The softened wax was contoured for the working occlusal contact by rubbing the dentures together on the articulator.

Fig. 15.—The rubbed denture contacts only on the second molar teeth in the balancing position of the articulator.

Fig. 16.—The teeth are set with enough curve to contact in protrusive positions. This also is corrected with the softened rubbed-in wax.

then filled in with wax. A petroleum jelly coating is applied to the occlusal surfaces of the teeth of both dentures; the wax is softened by brushing with a flame, and these surfaces are rubbed against one another on the articulator. This picks up and corrects discrepancies of articulation in the glides (Figs. 14, 15, and 16).

THE MOLD

After the wax is trimmed and polished to blend with the contour of the teeth, the anterior pin of the articulator being firmly fastened, a plaster mold is made of the teeth.

The lower denture and its mounting ring are removed from the articulator, and a new ring is attached. Sheet baseplate wax is contoured around the ring to a height which will permit it to be filled with plaster and imbed the upper teeth when the articulator is closed. This plaster must not include buccal surfaces of the posterior teeth. After the plaster is trimmed, it is notched on the buccal surfaces, separating medium is applied to facilitate its removal, and a stone matrix is made to assist in the carving of the buccal surfaces of the two wax tooth blocks. A similar operation is repeated to reproduce the lower posterior teeth. Thus molds are formed for all the posterior teeth (Fig. 17).

Fig. 17.—The mold for the upper posterior teeth is removed from the articulator, and the lower teeth are imbedded in plaster. Note that the buccal matrices have notched sides to aid in forming the buccal surfaces of the posterior teeth.

THE METAL INSERTS

The oclusal surfaces in the mold are flat and are of the correct pattern for the anti-Monson reverse curve, as well as the mandibular glides. It is our aim to produce metal cutting surfaces to correspond to these occlusal surfaces.

Twenty-six gauge sheet casting wax is cut into strips approximately 3/16 inch wide. These strips are now folded into accordian-like pleats which will not occupy more than ¼ inch buccolingually. Sometimes they will be considerably less. This will vary with the requirements of each patient. The number of pleats

will also vary with the concepts of the operator, no set rule having been established to this date. More pleats per inch mean more cutting blades.

The pleated wax is now pressed to conform to the occlusal surfaces of the mold (Fig. 18). The pattern of each insert is then sprued carefully, using several sprues since it is difficult for gold to flow through the many convolutions. The patterns are invested and cast.

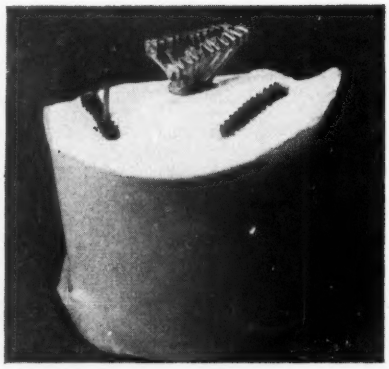


Fig. 18.—Pleated wax is pressed into the molds to form the occlusal pattern of the posterior teeth of one denture. The inserts for the other denture have already been cast and are shown in the background.

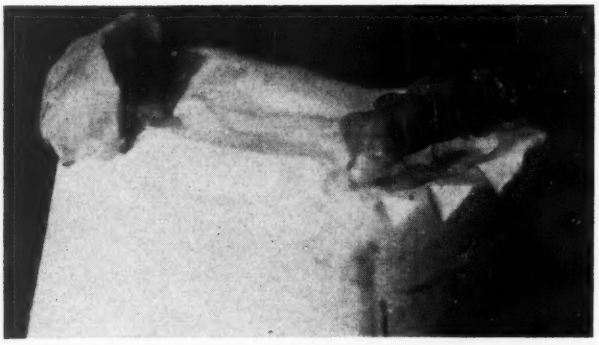


Fig. 19.—Wax has been placed on the posterior tooth block. The matrix is left on the mold on one side, and has been removed on the other.

We prefer to use a white, hard gold, but the patient should always be questioned first about his preferences. The average patient seems to prefer the white gold to a yellow one. After the casting has been trimmed and partly polished, it is tacked into the mold with a quick-curing methyl methacrylate material of approximately the correct shade.

Using the mold as a guide, wax forms are now created about the inserts (Fig. 19). This results in four wax blocks of teeth. These are all flasked together in

a denture flask, and the wax is boiled out. A masking material is now applied on the castings to prevent gray shadows (Fig. 20), and methyl methacrylate material of the desired shade is packed into the molds. The finished blocks of teeth now replace the teeth on the articulated casts which have been used to create the mold. The teeth are trued up on the articulator, and the dentures are processed.

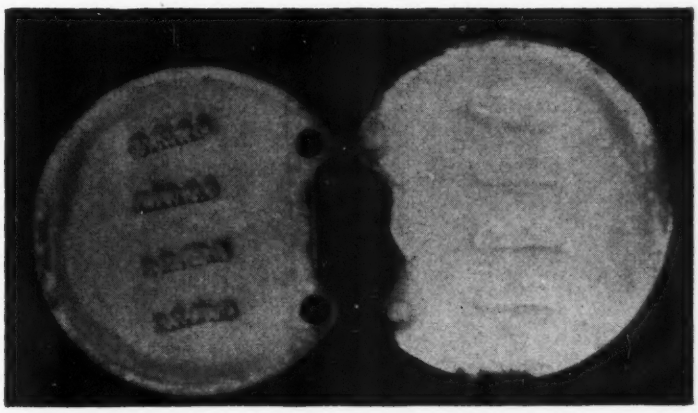


Fig. 20.—The wax has been boiled out, the metal inserts have been painted with a masking material, and the four tooth blocks are ready for packing with a suitable methyl methacrylate material.

FINISHING THE OCCLUSAL SURFACE

At this stage, the occlusal surfaces are flat and articulate in the desired manner. Very little of the metal inserts, however, is exposed. With fissure and other suitable burs food escapes, food arrestors, and cutting edges are now created (Fig. 21). On the upper posterior teeth, the acrylic material is cut away sufficiently to expose approximately 1.5 mm. in height of metal at the buccal cusp area. At the apex of a "V" on a tooth pointing toward the lingual, the insert is exposed only 0.5 mm. This acts as a food gatherer. Where the mouth of the "V," however, points toward the lingual, the acrylic material is sloped and grooved to facilitate passage of food toward the tongue, the knifelike edge of metal exposed being approximately 1 mm. in height.

Similarly, on the lower denture the same plan is followed, the difference being that sluiceways are designed to guide the food buccally. Thereby, the metal inserts will be exposed 1.5 mm. on the higher lingual cusp area, and about 1 mm. on the buccal side.

In this manner we have conformed to all the objectives we have set for ourselves (Fig. 22). I have made altogether too few of these dentures to date to estimate their value statistically. At this time I am very happy with the results, having tried them on extremely difficult patients.

Fig. 21

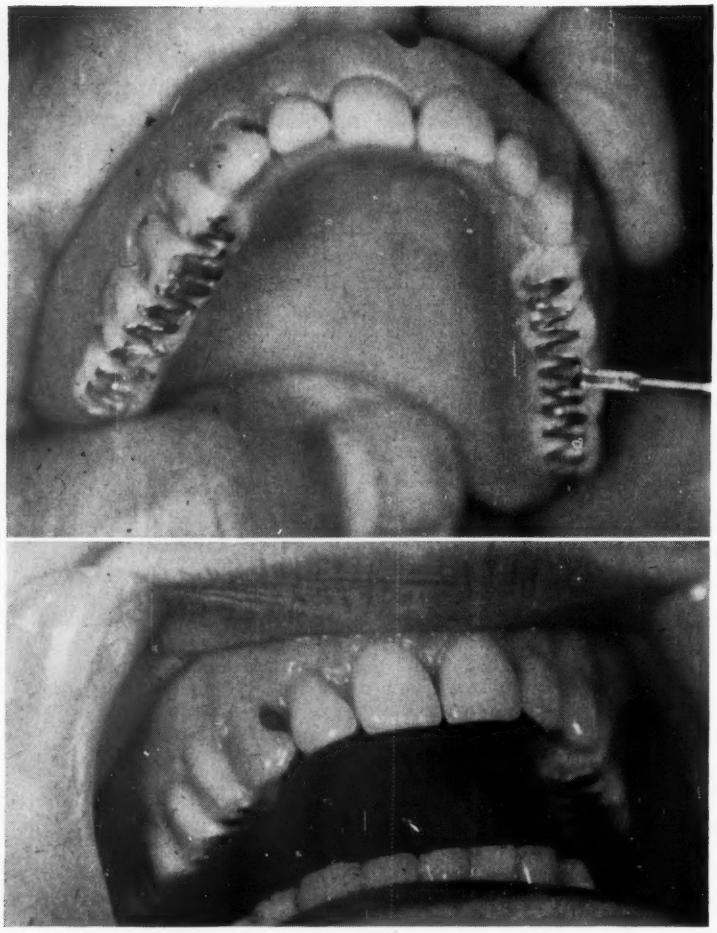


Fig. 22.

Fig. 21.—The metal inserts are cut in accordance with the plan described.
Fig. 22.—The finished dentures in the mouth.

SUMMARY AND CONCLUSIONS

1. It must be recognized that the glides generally produced on an adjustable articulator have little to do with masticatory efficiency.

2. The masticatory stroke is generally in a vertical direction requiring mechanisms to meet the specific requirements of cutting edges moving upward and inward.

3. The neuromuscular system is a protective mechanism designed to search for situations of greater comfort and efficiency. It may be the reason for alterations in the pattern of the chewing cycle indicated by Jankelson.

4. Bruxism is more prevalent than is generally believed.

5. Artificial teeth should be so arranged that bruxism causes a minimum of damage to the tissues.

6. Teeth should also be arranged so that the lower denture is stabilized during mastication.

7. A method of creating artificial posterior teeth designed to meet the requirements for efficiency, bruxism, and stability of the lower denture is described.

The primary aim of this article is not to exhibit a new type of posterior tooth. Rather, it is to indicate the problem of creating dentures which meet physiologic requirements and combat pathogenic conditions. To meet these requirements, applied physiology should become a major study, and methods should be devised to meet the laws which become apparent. This will result in better dentures. Thus theory based upon the known facts is met by practice. This is the way we achieve progress. I, therefore, do not subscribe to the words of Alexander Pope:

> "Be not the first by whom the new are tried
> Nor yet the last to lay the old aside."

There should be a qualification. When the "new are tried," they must be based upon adequate knowledge and sound theory. If there was no one in dentistry to try the new, research would be stifled. We have reason to be proud of those dentists who made progress because they tried the new. They are responsible for the great strides which our profession has made.

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ABUTMENT SITES AND SPACES IN PARTIAL DENTURE CASE ANALYSIS

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THE SYSTEM OF case analysis aims at the reorganization of available data so that the plan of treatment may be executed in logical sequence. Acumen in diagnosis is directly proportionate to familiarity with the variables, the physiologic and mechanical considerations, which abound in oral restorative procedures. A competent diagnosis requires meticulous study of every aspect of a problem; the diagnostic process must be repeated step-by-step for each patient examined. When all the problems have been exposed, evaluated, and correlated, a logical treatment plan will follow.

A review of the application of diagnostic efforts to partial denture problems reveals that most of the general procedures—the case history, clinical and roentgenographic studies of the teeth and their support, and surveying of the study casts for the purpose of planning the partial denture restoration—have been adequately systematized. *Problem analysis* is the point at which our analytic and synthetic technique requires new emphasis by means of a sequential approach.

In these studies we shall assume that the problems of periodontal and pulpal physiology have been evaluated in the clinical and roentgenographic diagnostic procedures, that all the natural teeth present are physiologically suitable as abutments, and that the mucosa is of average thickness and resilience. We may also assume that the vertical dimension and centric relation have been established in the mounted study casts.

The primary objective to be sought by the dentist in partial denture prosthesis is the *maximal restoration and maintenance of function.* Although, in the evaluation of the *total* problem, other aspects such as esthetics, phonetics, or hygiene may be regarded as more important to the ultimate success of the restoration as a whole, the starting point should always be *function.*

TOOTH- AND TISSUE-BEARING PROBLEMS

It is axiomatic that maximal physiologic restoration of function is best achieved in an all tooth-supported restoration, as differentiated from a tooth- and tissue-supported denture, or one entirely tissue-supported. An appraisal is made of the study cast to determine whether natural tooth distribution in the arch is favorable for an all tooth-supported partial denture; a decision is reached on whether the restoration will be chiefly tooth-borne, or chiefly tissue-borne, and

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the proportions of each. The first requisite is to secure as much tooth support as possible without exceeding physiologic tolerance. This will provide optimal functional efficiency in mastication; it should be the primary aim in prosthetic planning.

The evaluations can perhaps best be studied if the dentist visualizes the placement of blocks of teeth in the arch, which are waxed to a baseplate, and which replace the edentulous spaces. All the possible actions of the partial denture in its relation to the natural teeth and the mucosa may be anticipated more realistically, and the problems delineated more thoroughly (Fig. 1).

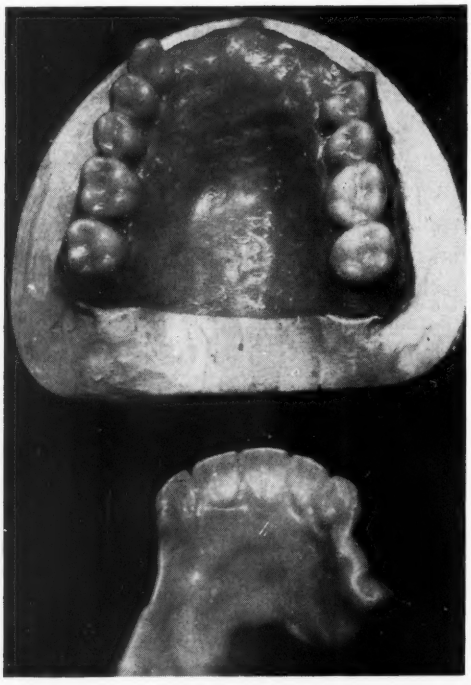

Fig. 1.—Teeth waxed to a baseplate for studying potential actions of a partial denture restoration.

POSTERIOR SEGMENT

First cognizance must be takeen of the centers of functional stress—the critical areas of rhythmic masticatory activity. An examination is made of the area where the brunt of masticatory force is applied (the lower first molar area, and the upper second bicuspid-first molar area). The most desirable situation is one in which *natural teeth are present* at this site. Where there are one or more natural teeth present in this area, bilaterally in the upper and lower arches, a relatively large measure of masticatory efficiency may be anticipated in the restored mouth.

If there are no natural teeth at this site in the segment, consideration should be given to the effective replacement of the space by means of an all tooth-supported partial denture section. A posterior bounded space (*B*) space[1] with one or more distal, or terminal, abutments present lends itself to a tooth-supported design; therefore, the space can be restored functionally. The criterion, in general, is whether a fixed bridge which would function efficiently and physiologically could be constructed for the space. If so, a tooth-supported denture section may be planned.* A posterior missing segment with no distal terminal abutment (*C*) space[1] is the cantileveer, or free-end type. When the functional chewing teeth are missing, and when the replacement for these teeth is not wholly tooth-supported, masticatory efficiency is not completely restorable. That segment of the arch will function, after restoration, with less than natural tooth efficiency because the replacement is not wholly tooth-supported. Where the modifying factor of abutment distribution permits, most posterior spaces are preferably replaced by fixed bridges. In general, free-end saddles preclude the determination for an all tooth-supported denture.

The cantilever (*C*) space cannot, and should not be chiefly tooth-supported. It should be chiefly mucosa-borne, or tissue-supported. Where a cantilever segment length of two or more teeth exists, it must be presumed that there will be a considerable diminution in restorable chewing efficiency in the segment, compared to the efficiency of the segment if all natural teeth were present, or if the space were bounded distally. The dentist must adjust his objectives accordingly; he should make an honest decision regarding how much function is restorable. He should study the distribution of potential abutments with the basic alternatives of tooth and tissue bearing in mind, and note the problems and potential sources of stabilization.

Patients in whom the natural teeth adjacent to the edentulous spaces are not the most advantageous for carrying supportive-retentive units should receive careful attention. A lateral incisor, with a small or weak crown and root, adjoining a large space may require splinting to its neighbor. On rare occasions, it may be desirable to bypass an ineffectual tooth, and utilize a more favorable tooth as an abutment.

ANTERIOR SEGMENT (*A*) SPACE[1]

The anterior section of the arch (cuspid to cuspid) is studied with respect to tooth and tissue bearing potential from several aspects: (1) incising function, (2) interarch tooth-to-tooth relations, (3) esthetics, (4) phonetics, and (5) habits.

Incising Function.—For consistency within the frame of this concept, the dentist must first consider an anterior space problem from the viewpoint of restoration of *function*. Incision, as a part of the arrhythmic phase of total masticatory activity, is not an especially important problem. The area of efficient and habitual incision need not be functionally restored in a prosthesis for most

*For the purpose of partial denture case analysis, we must presume that a partial denture solution has been decided upon.

individuals with the same closeness and depth of vertical overlap of the average natural dentition. Some latitude is permissible in the arrangement of the anterior teeth to conform with the other requirements of anterior segment restorations. Overbite (vertical overlap) may often be reduced to zero where esthetics permit. Overjet (horizontal overlap) may be increased to give added anterior clearance, or reduced to facilitate protrusive balance.

A tooth-borne anterior partial denture section is sought as first choice, as in the posterior bounded segmental problem. All discrete anterior segments are bounded bilaterally by abutments; the dentist should apply his diagnostic skills to the evaluation of the problem, particularly in *A-C* cases, where a reciprocal anteroposterior tilt of the partial denture may be anticipated (Fig. 2). This destructive effect should be reduced to a minimum wherever it can be foreseen.

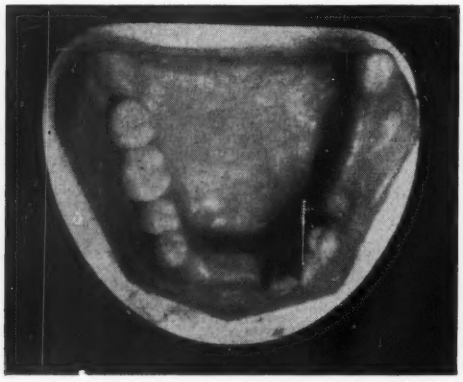

Fig. 2.—*A-C* spaces, reciprocal anteroposterior tilt.

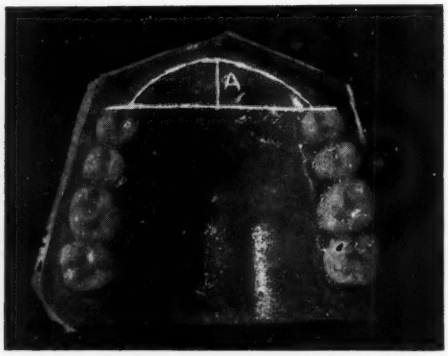

Fig. 3.—Lever arm *A*.

Large anterior spaces present a problem in lever action which is much more acute in the triangular arch than the oval type. Where the length of lever arm *A* (Fig. 3) is adjudged to be in excess for a potential fixed bridge solution, consideration must be given to a more tissue-borne solution. As in the case of the cantilever posterior segment, the dentist must re-evaluate the potential efficiency of the replacement from the point of view of tissue-borne, rather than tooth-borne, function.

Incisal Relations.—Where the entire anterior segment is missing, considerable latitude in anterior tooth arrangement is possible. The teeth may be set in various relations to the opposing jaw, limited by the space available between the edentulous ridge and the opposing teeth, and by esthetic and phonetic requirements. Some mouths exhibit only slight tendencies to extrusion of teeth. In these arches, the anterior teeth may be set up so that they do not touch the opposing teeth in any mandibular position. In other patients, the teeth show considerable tendency to extrude when they are unopposed. These require a contact with the opposing natural anterior teeth, or a shelf (in the palatal area) for the

engagement of the incisal edges of the lower anterior teeth in habitual closure, so that they will not tend to extrude.

Esthetics is closely allied with incisal relations, and is influenced by muscular kinetics. The patient who speaks, smiles, etc., without moving his upper lip has a relatively simple problem of esthetic replacement, compared to the patient who lifts his lip high when smiling and speaking. Decision and compromise lie within the considered judgment of the dentist. The fewer missing teeth in the anterior arch, the less freedom of choice the dentist has in positioning the replacement teeth, but on the other hand, the less strain may be anticipated in this section of the appliance.

Phonetics.—The dentist does not always have an opportunity to evaluate the patient's phonetic habits prior to the loss of the anterior teeth. If the patient presents himself with anterior teeth missing, it is difficult to judge his phonetic skills; nor can the manner in which his tongue and lips will adapt themselves to new surface contours and textures be predicted with assurance. Prudence must be exercised in evaluating the phonetic outcome.

Habits may influence the decision regarding all the previous considerations. In incising function and incisive relation, the relative frequency with which the patient makes incisive contact during the day, at mealtime, and between meals, affects the estimate of the magnitude of stress to be anticipated. Some patients habitually clamp their anterior teeth. Others rarely bring their anterior teeth together in incisive position, and may require a shelf or ledge in the prosthesis to prevent extrusion of opposing teeth. A habitual anterior chewing habit is a significant factor.

ABUTMENT PROBLEMS

The case analysis proceeds to the consideration of abutment problems. Problems of periodontal and pulpal physiology are presumed to have been evaluated in the clinical and roentgenographic studies. We shall assume that all the natural teeth present are physiologically suitable as abutments, for the purpose of our analysis, and that the mucosa is classified as "average."

THE ISOLATED TOOTH PROBLEM

The value of an isolated tooth present in an arch, and its unique requirements, are not always fully recognized. If the cast is examined as it exists, and then visualized with the isolated tooth *missing,* it is easier to appreciate the service required of the tooth when it is harnessed as an abutment.

Isolated teeth may occupy three types of positions:

1. *Anterior Tooth.*—The isolated anterior tooth helps support the anterior partial denture section. A long anterior space will allow free play to an anterior rocking action (Fig. 4), and only the anterior mucosa can be utilized to resist the displacing forces.[2] Even a single tooth will help resist displacing and settling action.

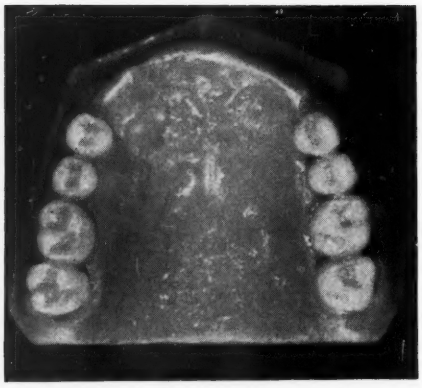

Fig. 4.—A large anterior space, anticipate anterior tilting.

Fig. 5.

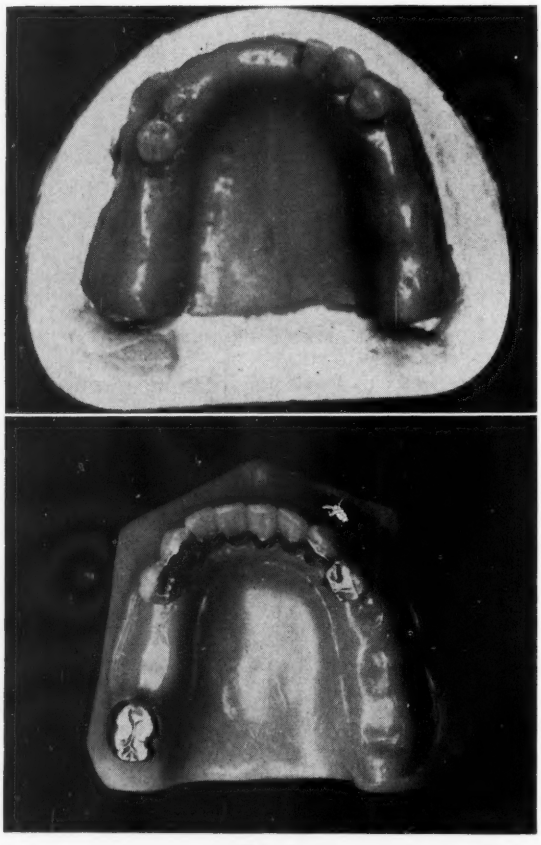

Fig. 6.

Fig. 5.—An isolated intermediate tooth dividing two long spans.
Fig. 6.—Anterior teeth supplied on fixed bridge may be used for indirect retention.

2. *Intermediate Tooth.*—The isolated bicuspid tooth is involved in the problem of anteroposterior, or mesiodistal, tilt. It grows rapidly more acute as the adjoining spaces lengthen (Fig. 5). The anteroposterior rocking problem is one which usually involves an anterior segment and a posterior free-end segment, interrupted by one, two, or at most three teeth.

Where there are natural anterior teeth present, or anterior teeth are supplied on a fixed bridge, the partial denture may be retained against them indirectly (Fig. 6).

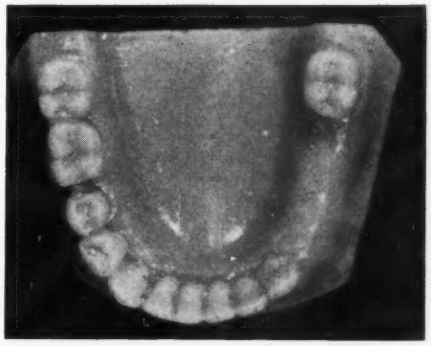

Fig. 7.—A terminal posterior tooth.

3. *Terminal Posterior Tooth.*—An isolated molar would be considered in this classification (Fig. 7). It is usually regarded as highly desirable to have a tooth present at the distal terminus of a posterior edentulous space for the purpose of planning a tooth-supported section of a partial denture. The solution of the space problem, whether by a fixed or removable appliance, is almost always superior to a mucosa-supported replacement from the functional point of view. Although this is an established truism, we frequently observe that the posterior abutment loosens rapidly when it serves as a supportive-retentive unit. The tooth mobility is caused by torsional play, especially in cases where the other side is free-end. Due to the cantilever rocking action of "horseshoe" types of partial dentures, the free-ends are in the area of greatest strain and movement. Though the isolated terminal tooth serves well as a bracing, supportive, and retentive unit, it is also in the "resultant zone" of stress, subject to "whiplash torque" at the end of the segment arm, where the force spends itself. Designing the supportive-retentive (clasp-rest, or other) device should be planned with care to minimize damaging stresses to this useful abutment. When two contiguous terminal abutments are present, and properly utilized, the prognosis is much better.

PROBLEMS OF SEGMENTAL RECIPROCATION

The second problem in connection with tooth distribution is whether they are favorably situated for reciprocal bracing.

The basic types of problems in this category are those in which an isolated tooth or two adjacent teeth separate two spaces (*A-B* or *A-C*), and bilateral (*C-C*) spaces. This type of problem increases rapidly in magnitude in proportion to the increase in size of the spaces. Edentulous segments embracing anterior missing teeth continuous with missing posterior teeth, i.e., a space which rounds the cuspid turn, are especially awkward, either alone or in reciprocal relation to a cantilever posterior (*C*) space (Fig. 8).

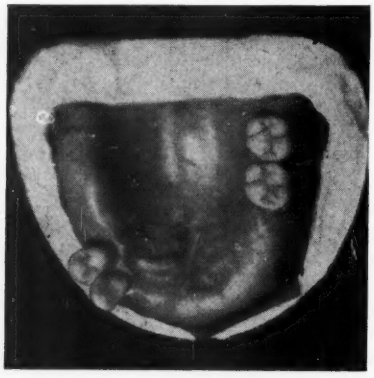

Fig. 8.—Anticipate a severe diagonal tilt.

Tilting (or rocking) action may be classified as (1) anterior tilt, (2) posterior tilt, (3) anteroposterior tilt, (4) diagonal tilt, and (5) lateral tilt.

Anterior Tilt.—An upper anterior partial denture section will tend to tilt anteriorly under stress of closure. The lever arm is perpendicular to a line drawn through the most anterior fulcra bilaterally, and extends to the most anterior point of incisal tooth contact (Fig. 3).

Fig. 9.—The tilting arm of the denture section extends from the distal of the first bicuspid to the distal of the posterior flange.

Posterior Tilt.—A posterior cantilever partial denture section tends to tilt posteriorly from the most distal fulcrum point on an abutment to the most distal point of the denture flange (Fig. 9).

Bilateral posterior cantilever spaces (*C-C*) give full play to posterior tilting action as a result of the relatively vertical stresses of arrhythmic and random closures (swallowing, speaking), and of rhythmic mastication.

Anteroposterior Tilt.—Where an anterior space is discrete from a posterior space unilaterally, closing stress on the posterior segment will produce displacing action on the posterior segment, and a reciprocal lifting impulse in the section anterior to the most distal abutment fulcrum. In corollary, incisive stress will effect displacing action of the anterior section, with consequent lifting of the section posterior to the most anterior *abutment* fulcrum.

Diagonal tilt can occur where a posterior cantilever space is discrete from an anterior space on the opposite side of the arch. It is more severe if there is a space of a few teeth of the opposite posterior segment continuous with the anterior space (Fig. 8). The main fulcrum is the first rest proximal to the section receiving the stress of mastication. The fulcrum action is frequently modified by interaction of other parts of the partial denture with the abutments and mucosa.

Lateral Tilt.—Horizontal forces in a bilateral free-end partial denture produce reciprocal stresses across the tongue space. The component of masticatory forces directed to the buccal on one section will produce a dislodging effect on the opposite free end. Forces to the lingual on one side will result in tissue-displacing (seating) stresses on the opposite section.

Other anatomic considerations, such as ridge and arch relations, and root form and number are intimately related to abutment distribution problems, and must be evaluated. Occlusal problems and their magnitude, and problems of settling and rate of ridge resorption should be noted. A free-end denture segment will tend to settle, as will a segment of excessive span length with inadequate tooth support, more than one that is all tooth-supported.

SUMMARY

The system of case analysis serves as a guide to the *isolation* of stress elements in a partial denture case, to their *evaluation,* and to the *integration* of the parts into a treatment plan. The dentist must secure basic data to guide him in case planning.

The initial approach to case analysis is a survey of the following problems in the patient under consideration:

I. Segmental Problems
   Types of missing segments
   - A. Anterior space
   - B. Bounded posterior space
   - C. Cantilever (free-end) posterior space

II. Specific Stress Problems
   1. Vertical
      - a) Displacing
      - b) Dislodging

2. Horizontal
3. Torsional

III. Tooth- and tissue-bearing problems

IV. Isolated tooth problems

V. Segmental reciprocation problems

Adherence to this system affords the dentist the opportunity to think through the variety of stress problems which he must expose before planning a restoration. It is an aid in the *visualization* of case problems. In learning this approach to partial denture problems, it will be found that a more intelligent evaluation is made if the dentist proceeds according to the outline presented. Recourse to engineering terms and principles should be minimal, most of the stresses and strains are definable in terms commonly used by the dentist. The system has both an outer shell and an inner core. The outer shell is the outline. The core is the analytical skill of the individual applying his knowledge and sagacity to the case. If the outline becomes an end instead of a means, it fails to fulfill its purpose. This outline of *case analysis* possesses a cumulative framework, giving constant emphasis to the dentist's own thought and judgment.

By means of systematization of an analytical procedure embracing a few aspects of partial denture planning, dentists may make a first step toward thinking alike in their diagnostic studies of stress problems in partial denture construction.

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A PRACTICAL APPROACH TO EXTENSIVE RESTORATIVE DENTISTRY

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SO-CALLED ORAL rehabilitation is a vast and debatable subject. It is vast because it embodies the execution of the services of all branches of our profession, from the insertion of a single gold inlay in one instance to extensive crowns and bridges involving the entire occlusion in another. It is debatable because of the many conflicting opinions and procedures recommended in the correction of abnormal oral conditions.

The two important achievements desired in extensive restorative dentistry are (1) esthetic improvement, and (2) functional occlusal improvement. The patient's acceptance of so-called oral rehabilitation is most often influenced by the desire for pleasing and natural-appearing teeth. Today, the demand for esthetics in dental restorations is great. Malposed teeth and objectionable spaces may embarrass and even humiliate some emotional people. Sometimes such teeth affect and control the smile to such a degree as to bring about a grimace. If it is within our means to improve upon an unattractive dentition, we should not hesitate to cover teeth with restorations which will overcome that unattractiveness. I am firmly convinced that no other material can approach the natural esthetic qualities of fused porcelain. The weakness of porcelain is its fragility, but its color and form are constant. The weakness of plastic is its color and form, but its resistance to fracture makes it an acceptable medium to use in many instances. Plastic veneer crowns often prove satisfactory in the posterior part of the mouth, but for anterior teeth, porcelain jackets, porcelain veneer crowns, and porcelain bridgework will meet the esthetic requirements to the satisfaction of the operator and the patient.

It is my intention to present a treatment plan of classified cases of so-called oral rehabilitation which are likely to succeed when treated. By the same token, I will introduce the various limitations which will prevent the successful execution of treatment in other cases. Proper presentation of the treatment plan is most important. We should remind the patient that we cannot accomplish a result beyond the limitations of the mouth to be treated.

It should be possible to restore mouths without the use of geometric formulas, complicated instruments, and temporomandibular joint theories. It is brought to our attention, however, that the primary influential factor in establishing the occlusion is the temporomandibular joint. This concept, I believe, definitely requires more research, backed by reports of practical cases which have been treated

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successfully with a simplified technique which is available and understandable by the average practitioner. The adoption of a premise upon which to recommend procedures of treatment in any undertaking depends upon one's opinion. I like to apply the reasoning of Schlosser[1] who expressed the view that an open discussion of a problem can be easily converted into a prolonged controversy of doubtful significance, unless the participants are willing to grant to their confreres the right to their own opinions in spite of any existing diversity. Mindful that in differences of opinion there is progress, I submit a philosophy and treatment plan for so-called oral rehabilitation in a simplified form. This concept does not as yet accept the axiom that the hinge axis and the temporomandibular joint dictate the establishment of the occlusion. Some improper and unsatsifactory occlusions may contribute to temporomandibular joint disturbances, but the joint is not the important agent in formulating the articulation of the teeth.

Fischer[2] writes:

> If the temporomandibular joint is the omnipotent factor in establishing the occlusion and articulation of the teeth which it is made out to be, it seems difficult to understand why this factor would not assert itself during the period of mixed dentition. During this transition period, the permanent teeth are practically without roots and the deciduous teeth have lost most of theirs. Furthermore, at this age, the alveolar bone, the medium that makes orthodontic movement of teeth possible, is at its maximum plasticity. Certainly under such conditions, the teeth could not offer much resistance to their being naturally positioned in accordance with the dictates of the temporomandibular articulation. Yet few are the children who do not show some irregularity of occlusion, and balanced articulation is a rare phenomenon even in children with normal occlusion of teeth. This evidence is on the side of the argument that the temporomandibular joint is not the important factor in establishing the occlusion and articulation of the teeth. It must, therefore, be assumed that the primary factors in establishing the occlusion and articulation of the teeth, as well as the movements of the condyle in the glenoid fossa, are the forces exerted by the muscles surrounding the teeth and the ligaments supporting the mandible that limit these forces.

I am further influenced by Linghorne's theory[3] on the physiology of the masticatory machine. In discussing the beginning of occlusion, he expounds the belief that the teeth are guided into approximate position by the muscles of the lips, cheeks, and tongue until contact is made. Then the inclined planes of the cusps guide the teeth in their permanent position. Later on, these occluding teeth are held in position by the underlying structures. *This occlusion in man is established all before the temporomandibular joint is fully developed to do any dictating.* If the joint does not dictate the occlusion of the teeth and the movements of the mandible when they erupt and develop, why should we go to that joint for means of restoring an occlusion that has collapsed in middle age?

There is no one plan of treatment for the correction of dental ills in all cases involving extensive restorations. All mouths, all teeth, all jaws, and all occlusions are not the same. Nature does not construct uniformity. Fischer[4] writes:

> Nature is primarily concerned with function. The manner in which she accomplishes this in the body proves this to be true. She distorts or inhibits certain anatomic parts belonging to a complex physiologic unit in order to produce the best functional potential. The results of these compensatory adjustments are the various asymmetries in the body. Despite the fact that some of these are frequently of a marked degree, function is not impaired.

Mershon[5] wrote:

> In the quest for relief of every human ill, medicine has met with defeat every time it has ignored one unalterable condition of humanity, individual limitation . . . . When we realize that each germ cell is different from all others and that each of the millions of changes which takes place during the process of development to maturity makes each individual a being different from all other beings, how can we hope to lay down rules such as one might use in engineering?

Here we have two scientific, two philosophic factors, much too practical to ignore, namely: (1) asymmetries in the body, and (2) individual limitations.

THE ARTICULATOR

These two factors have a direct bearing upon any plan of treatment for each individual requiring restorations in a collapsed dentition. I believe that these factors overshadow the importance of any mechanical contrivance. Just a word about such a contrivance, the articulator. There are thousands of articulators, some simple and some complex. I find it difficult to concede the fact that a mechanical instrument can imitate, to any degree of accuracy, the manifold functional movements of the mandible. There are thousands of mandibular movements and each movement is different in each individual. "It is a fact, of course, that an articulator offers no more than a means to an end," writes Jordan.[6] *Any instrument which will facilitate the construction of restorations at the bench in the laboratory is a good articulator.* Many instruments contribute in various degrees to a satisfactory result in the hands of the individual who has a flair, and the experience with his particular articulator. I still believe, however, that registrations on the patient and transfers from the patient to any type of articulator cannot be without errors. The more steps required in establishing and transferring the records, the greater the chance for these errors. What supercedes in importance to the type of articulator is the *oriented* working cast.

The human jaw, with all its limitations, with all its interferences, and with all its individual problems, makes the best articulator in the final analysis. The operator should adjust the occlusal surfaces of his restorations to the dictates of that particular individual's tolerant and functional occlusal relationship before finishing and polishing. Consideration should be given to the patient's individual pattern of chewing, to the occlusal cant, to existing asymmetries, to a cross-bite if it had been present, to worn chewing surfaces on some teeth. These are all factors which no articulator can take care of accurately.

BALANCE IN A FIXED DENTITION

It is the opinion of some that no restorations involving the entire occlusion be constructed in a mouth containing natural teeth, until these natural teeth have been made to occlude in so-called balance in their various excursions by covering them with crowns possessing ideal interdigitating cusps. There are patients, and I think there are many, whose occlusions function most satisfactorily in eccentric positions. How important is balance in a fixed dentition? Why should we stress importance to mandibular movements which play no part in function? The pre-

sumably correct occlusal balance in one case may disturb the harmony of the masticatory machine in another. *We should not refer to a single plan with regard to occlusion to reproduce an ideal, picture-book type of balanced occlusion for all individuals.* Jankleson, Hoffman, and Hendron[7] investigated the physiology of the stomatognathic system and concluded, "There was no evidence that balance of teeth in eccentric positions is a physiological necessity, or that the lack of eccentric balance is less conducive to masticatory function." Fischer[8] states, "Nor is there evidence that placing teeth in balanced articulation will obviate positional irregularities of the teeth. Such irregularities can be traced to the dynamic and random forces peculiar to the functional pattern of the individual himself."

We must distinguish, however, between interfering cusps and so-called balance in excursions. Interferences should be reduced. We must be mindful that not all prematurities interfere with occlusion. Sometimes, such a prematurity may even be beneficial because it may act as a stop in the wearing away of certain areas on other teeth.

PRIMARY LIMITATIONS IN SO-CALLED ORAL REHABILITATION

Before I introduce a practical classification and treatment plan for extensive restorative cases involving the entire occlusion, I wish to call to your attention that corrective and restorative dentistry is controlled by inescapable limitations. There are seven primary factors which limit the plans of treatment *no matter what concept is followed:*

1. Different occlusal levels between the anterior and posterior teeth.
2. Asymmetries in the body.
3. The natural attritional wear of the occluding teeth.
4. The patient's individual pattern of chewing.
5. The patient's intolerance to any radical change in occlusion.
6. The patient's wishes.
7. The economic factor.

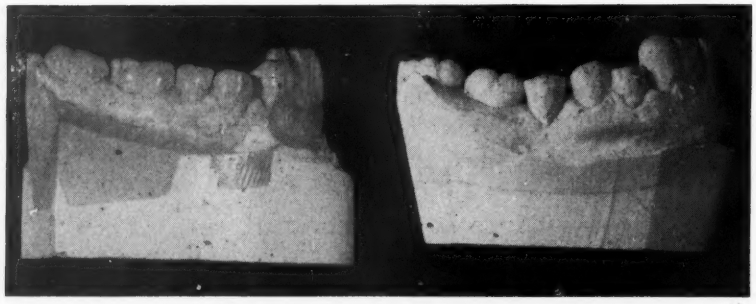


Fig. 1.—Different occlusal levels between the anterior and posterior teeth. The prognosis of completely rehabilitating such a mouth with a level, ideal, man-made occlusion is often unfavorable.

Patients with different occlusal levels usually possess carnivorous occlusions without marked lateral excursions (Fig. 1). The posterior teeth are not frequently

subjected to the rocking lateral forces, and as a result, the bone and surrounding tissues rarely show any marked detrimental effect. *To level off these anterior teeth with the molars and bicuspids would necessitate opening the vertical dimension, thereby placing abnormal stress upon the muscles and the teeth. In order that this stress be relieved, the soft alveolar bone would absorb, and the teeth would be driven deeper and deeper into the bone until the occlusion is once more in its original position.* Nor can I hold any faith in any bite-plate appliance that is supposed to depress the lower anterior teeth and at the same time make it possible for the posterior teeth to erupt further. This procedure in adults of middle age is just another form of "bite raising" which can only end in failure. The occlusion of such a patient should not be altered, and the prognosis of completely "rehabilitating" such a mouth with a level, man-made full-denture type of occlusion is frequently unfavorable.

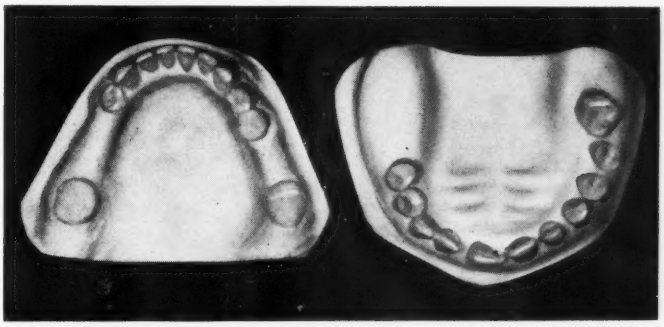


Fig. 2.—Asymmetric jaws. The upper jaw is sometimes wider than the lower jaw, and definitely influences and limits the plan of treatment.

Asymmetric jaws, teeth, muscles, condyles, etc., definitely influence the treatment plan (Fig. 2). Asymmetric muscles are contributing factors in uneven occlusal or incisal wear, and are quite a disturbing source of trouble when restorative work with gold, plastic, or porcelain is contemplated. How can we accept accurate restorations constructed on an articulator that is based upon the principle of the sphere when we know that the right side of the head and face is seldom the same as the left side?

When natural attritional wear of occluding teeth is uniform, usually in advanced middle age, it is the belief that there is a so-called decrease in vertical dimension. Schweitzer[9] writes:

> In these individuals, although the teeth are very short, the alveolar bone is very good and the gum tissues are healthy and firm, there is no evidence of pocket formation. Undoubtedly, here is direct evidence that the entire bony processes of the mandible including the alveolar bone have proliferated down en masse to compensate for the tooth wear and thereby maintaining the correct vertical dimension.

Any attempt to alter the occlusion of such patients is inviting trouble (Fig. 3). Uniform wear eliminates cuspal interferences, regulates the occlusion, and transmits the force of mastication parallel to the long axis of the tooth. All in all, this is a healthy, normal physiologic phenomenon. In spite of the worn

chewing surfaces, the gouged facets, and the old, not "pretty-looking" restorations, the function of the teeth is not impaired. The present-day materials used in our restorations do not possess the same scratch hardness nor wearing properties that the natural teeth have. As a result, any occluding restorations in such dentitions will not wear uniformly, and the underlying structures are bound to suffer. Such mouths, in general, should be left alone and the patient reminded that the teeth get old as well as the organs of the rest of the body. Since they function to satisfaction without detriment to the oral cavity, no extensive so-called rehabilitation is indicated.

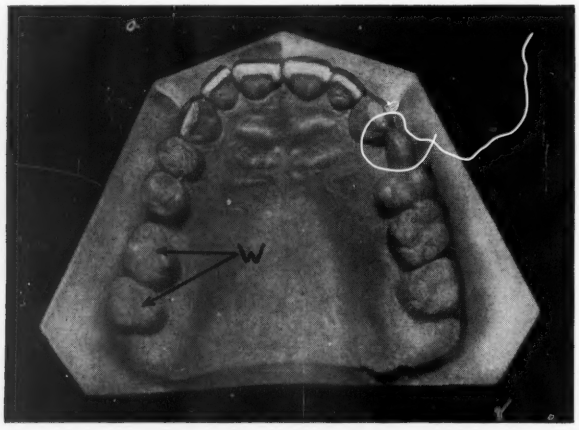


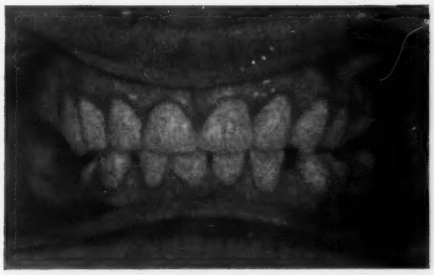
Fig. 3.—Natural attritional wear. This condition is a normal physiologic phenomenon which is kind to the underlying bone. The occlusion of such mouths should be left alone.

If, however, the borders of the facets are a source of irritation to the lips, cheeks, or tongue, or if pain or difficulty in mastication is experienced, then restorations may have to be attempted *without altering the existng tolerant vertical dimension.* It might be feasible to use a softer gold for the occluding surfaces of the restorations with the hope that less damage to the underlying bone and tissues will result. More often, the desire for esthetic improvement is the factor which compels these individuals to seek "reconstruction." If the teeth are too short to accommodate esthetic crowns, then cutting away some of the thick plentiful gum tissue is advocated to expose more of the crowns of the teeth (Fig. 4*A*). After healing, the teeth are prepared to receive the esthetic crowns (Fig. 4*B*). Extensive restorations on attritionally worn teeth in patients of middle age are often unfavorable.

The fourth important factor which limits us in restorative work is the patient's individual pattern of chewing, with muscle pull a dominant factor. This is sometimes manifested by occlusal or incisal wear of some teeth. Figs. 5*A* and 5*B* illustrate the oriented study casts of a patient whose manner of chewing contributed to the wear of the incisal edges of the lower anterior teeth. Notice how the upper central and lateral incisors fit into the worn incisal edges of the lower anteriors;

how the pointed cusps of the upper canine and bicuspids accommodate themselves into the wide spaces of the lower teeth. When restorations are indicated, consideration must be given to this patient's pattern of chewing which is an individual phenomenon. Completely "rehabilitating" such a mouth, creating a so-called ideal occlusion by closing up the spaces and leveling off the worn incisors with porcelain jacket crowns will be detrimental to this patient's masticatory apparatus, and the

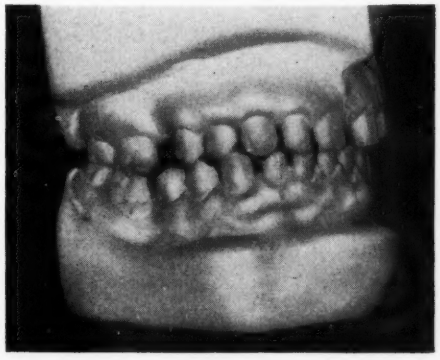
A.



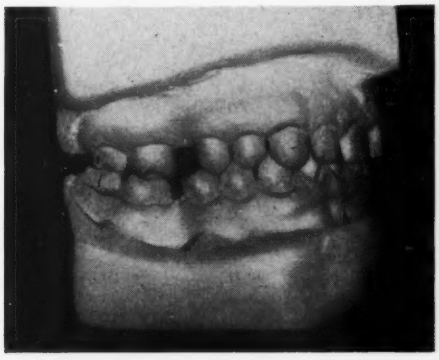
B.

Fig. 4*A*.—Short attritionally worn teeth unable to retain esthetic crowns.

Fig. 4*B*.—Same case after thick gum tissue had been cut away and porcelain crowns were constructed.



A.



B.

Fig. 5*A*.—Study casts illustrating the patient's individual pattern of chewing. Note the worn incisal edges of the lower anteriors.

Fig. 5*B*.—Same case in centric occlusion. The pointed cusps of the upper canine and bicuspids accommodate themselves into the spaces of the lower teeth.

porcelain crowns will break. We must be mindful that muscular habits in patients of middle age cannot be readily changed. The operator should maintain this worn relationship in any restoration if the worn teeth are to support bridges. Sometimes uneven occlusal or incisal wear on teeth in some parts of the jaw is brought about by bruxism. The cutting of such worn teeth, and restoring them

with full coverage crowns of original length will not stop the bruxism. Furthermore, the pounding of these newly covered teeth will not be tolerated during the grinding and gnashing.

Radical alteration of occlusal patterns in teeth of people of middle age may disturb the patient's manner of chewing because the patient cannot tolerate the change. It may affect the nervous system of the individual. It may affect the harmony of the muscles and the hard and soft tissues of the jaws. Teeth which once possessed sharp, inclined planes have become flatter by wear, and the operator should bear this fact in mind when planning extensive restorations of crowns and bridges. It is not always advisable to construct deep fissured, overcarved interdigitating cusps which tend to contribute to trauma. Invariably, whenever I constructed deep carved cusps on restorations, I was compelled to reduce them. The jaws of a man of 50 years cannot always tolerate restorations on teeth constructed so as to resemble those of a young man of 20 years. By the same token, restorations with completely flat occlusal patterns often prove inadequate in masticatory function. *The preference is for crowns with low cuspal inclines possessing some sluiceways, and with lesser buccolingual widths than the natural teeth.* Unfortunately, the patient's tolerance to a change in occlusion cannot be measured beforehand.

The patient's wishes quite often influence our plan of treatment. When these wishes do not affect the health of the patient, we are often placed in the position of considering them. Usually the patient of middle age objects to any display of gold in anterior restorations or the tying together of anterior teeth which may change the anatomic forms of such teeth.

The economic factor in private practice definitely influences the plan of treatment in extensive restorative work. Because of it, it may be advisable to do sectional treatment. It is necessary, however, in such cases, to outline the procedures contemplated for the entire mouth with the understanding that sections of the mouth will be completed over an extended period.

Which patients are likely to respond successfully to treatment? In most instances, we are called upon to restore a collapsed dentition due to the absence of teeth. *This type, Group 1, includes patients with the entire occlusal relationship lost because all the posterior teeth in one or both jaws are absent. Another type, Group 2, consists of patients with some natural teeth in each jaw and possessing satisfactory occlusal relationship.*

PROCEDURES IN RESTORING A COLLAPSED DENTITION DUE TO THE LOSS OF ALL THE POSTERIOR TEETH IN ONE OR BOTH JAWS

A full series of roentgenograms and *oriented* study casts are important preliminary prerequisites in the treatment planning. The full-mouth impressions should be made in alginate or hydrocolloid material, but never in wax or impression compound. The plan of treatment should be fully discussed with the patient, who should be acquainted with the limitations and problems of the case. An honest and frank discussion often prevents misunderstandings.

The basic instrument used in orienting the study casts as well as the working cast is the Fischer[10] Dentiphore (Figs. 6, 7*A*, and 7*B*). Measurements taken on the head with this instrument are transferred to a platform upon which the dentiphore is mounted. A study or working cast made with the Dentiphore is related to

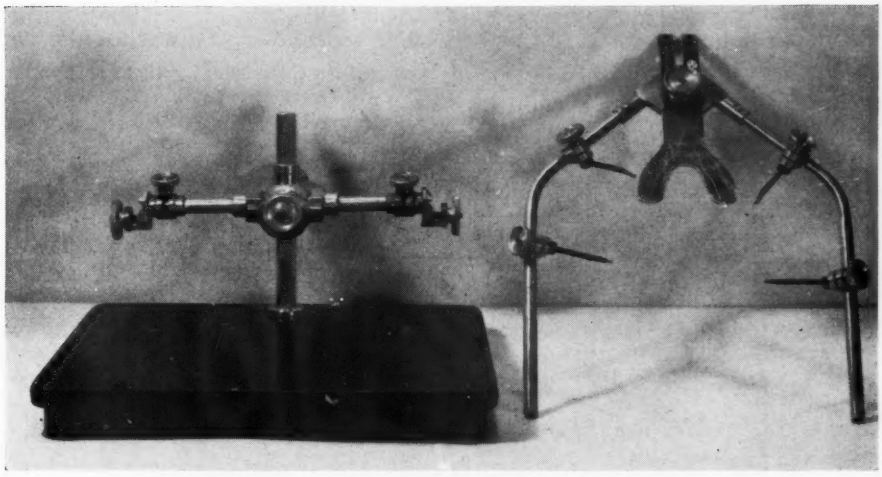


Fig. 6.—The Bercue Fischer Dentiphore.

A. *B.*

Fig. 7*A*.—Markings on the face for the pointers of the Dentiphore. *P*, Preauricular point; *O*, orbital point.

Fig. 7*B*.—The Dentiphore is applied to the markings with the bite fork in position.

four planes of the skull (Fig. 8). These are: (1) the preauricular plane, (2) the orbital plane, (3) the Frankfort plane, and (4) the median line. Such a cast will disclose asymmetric influences. Such a cast will provide us with an occlusal cant as it is related to these planes (Fig. 9*A*).

Fig. 10 illustrates the study casts of a patient, a woman of 55 years. Note the missing posterior teeth in the lower jaw, and the collapse produced a fanning of the upper anterior teeth, with objectionable spaces which disturbed the patient very much (Fig. 11). Here is a case where functional as well as esthetic improvement has to be accomplished.

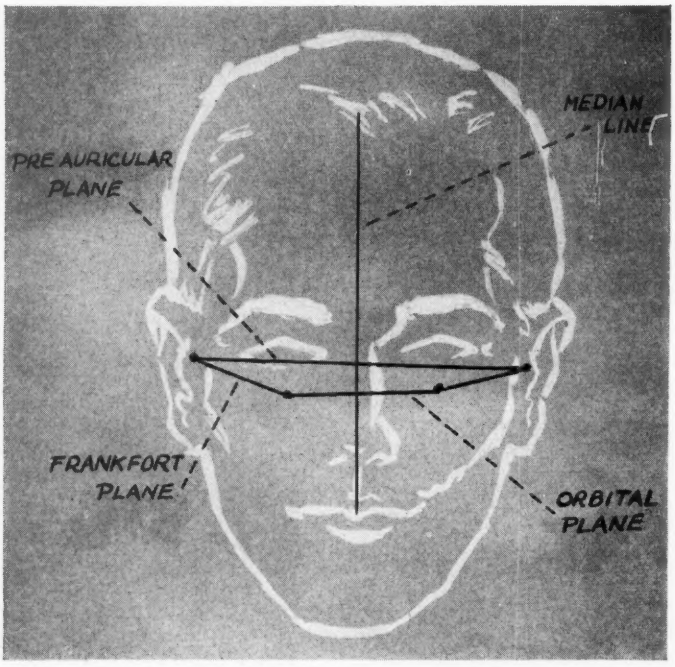


Fig. 8.—The four planes of the skull to which the working as well as the study casts are oriented.

Inasmuch as the working cast (the cast upon which the restorations are to be constructed) will be oriented to the patient's skull, the upper teeth are prepared first. Dies are constructed, transfer copings are made, a full upper impression is made in plaster, and the stone cast is poured in the conventional manner. Facial markings are made to adapt the dentiphore (Fig. 7*A*). These markings are located as follows according to the directions of Fischer[11]:

> *The Preauricular Points.* These are determined as follows: With a skin pencil, a vertical line is drawn marking the base of the ear. This is the preauricular line. Another line, the tragial line, is drawn horizontally bisecting the tragus of the ear and intersecting the preauricular line. The point of intersection of these two lines is the tragial point. With the tip of the index finger the zygomatic arch is palpated and the preauricular point marks the junction of the posterior root of the zygomatic arch

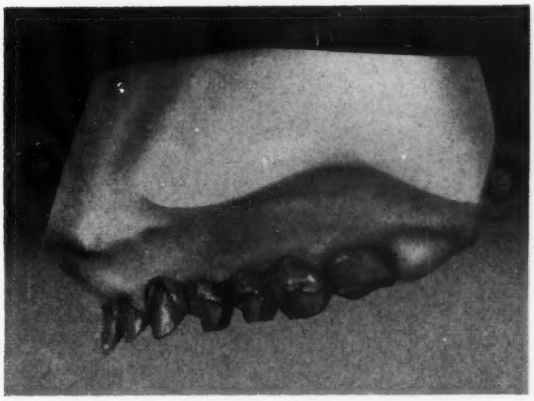


Fig. 9*A*.—A working cast poured in the conventional manner

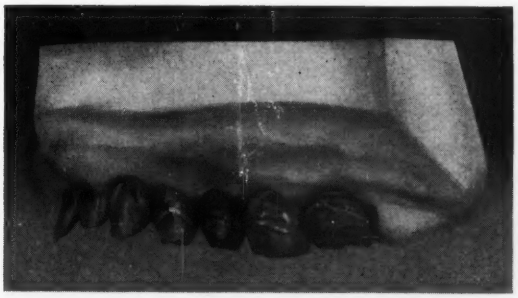


Fig. 9*B*.—Same working cast oriented to the patient's skull. Note the occlusal cant.

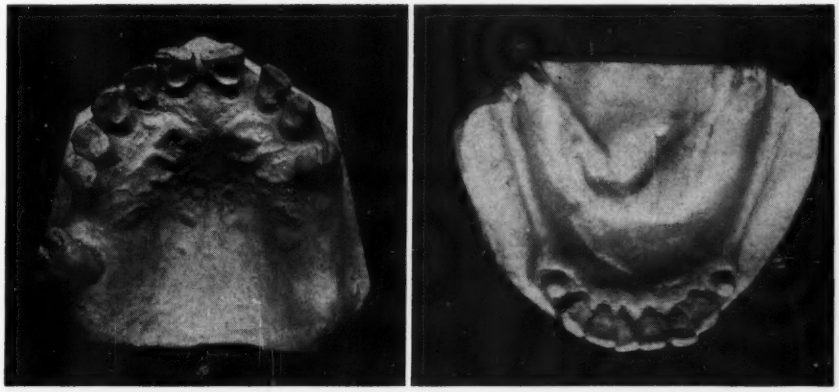


Fig. 10.—Study casts of a collapsed occlusion due to the absence of all the posterior teeth in the lower jaw.

and the preauricular line. The locating of the preauricular point from the tragial point is measured and this measurement is used to locate the preauricular point on the right side after locating the right tragial point.

The Orbital Points. These are located by placing the mark on the lower rim of the orbit directly in line with the pupil of the eye when the patient is looking straight ahead.

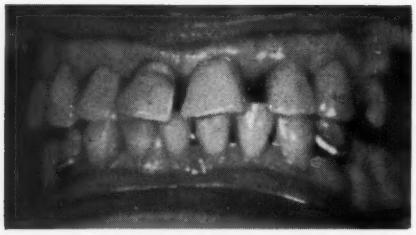


Fig. 11.—Front view illustrating the objectionable spaces. (Same patient as in Fig. 10.)

The temporary restorations are removed from the upper jaw. The patient is instructed to bite into the wax-covered bite fork. This is just a registration to seat the previously poured working cast. The instrument is applied to the patient's head, with the points on the facial markings, and with the bite fork in position.

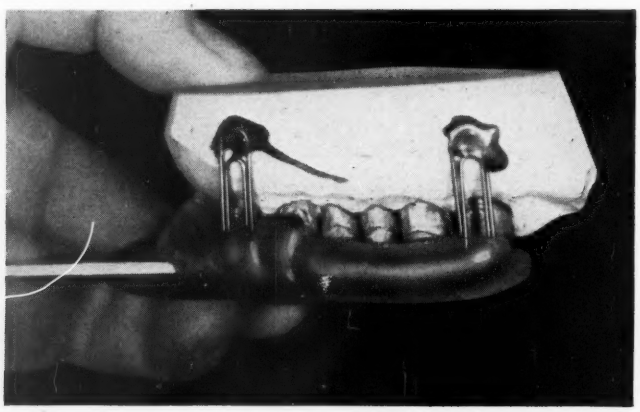


Fig. 12.—The working cast is luted to the bite fork with paper clips.

The face-bow and fastened bite fork are removed. The previously poured working cast with the seated dies is luted to the bite fork with small paper clips (Fig. 12). The luted cast is now immersed in a bowl of water for five or ten minutes to facilitate proper union with the new plaster base.

The four pointers of the Dentiphore are transferred to the platform so that the platform automatically becomes identical with the Frankfort plane (Fig. 13). At least three of the pointers must touch the platform. These pointers are now fixed in that positon. The bite fork and luted working cast is fastened to the face-bow, and then surrounded by a boxing of carding wax (Fig. 14). A large bowl

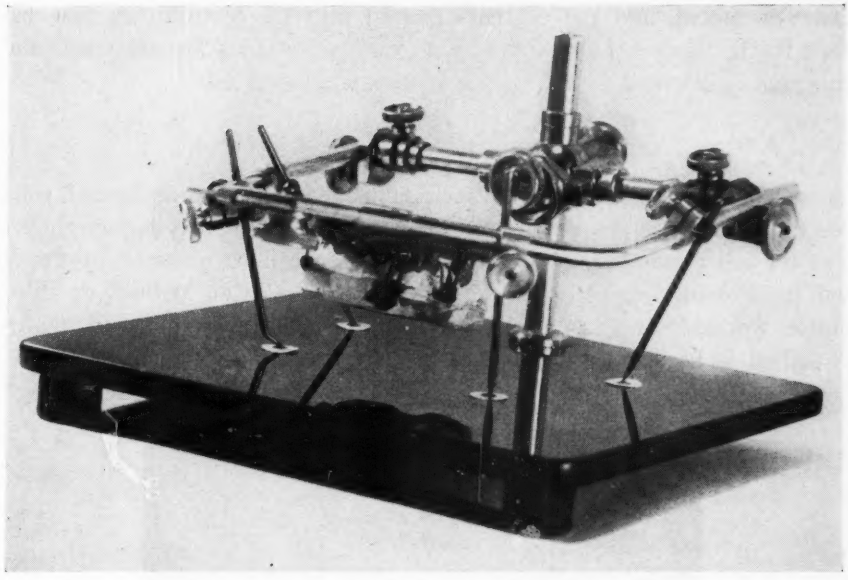


Fig. 13.—The face-bow is transferred to the platform. The platform becomes identical with the Frankfort plane. At least three of the pointers must touch the platform.

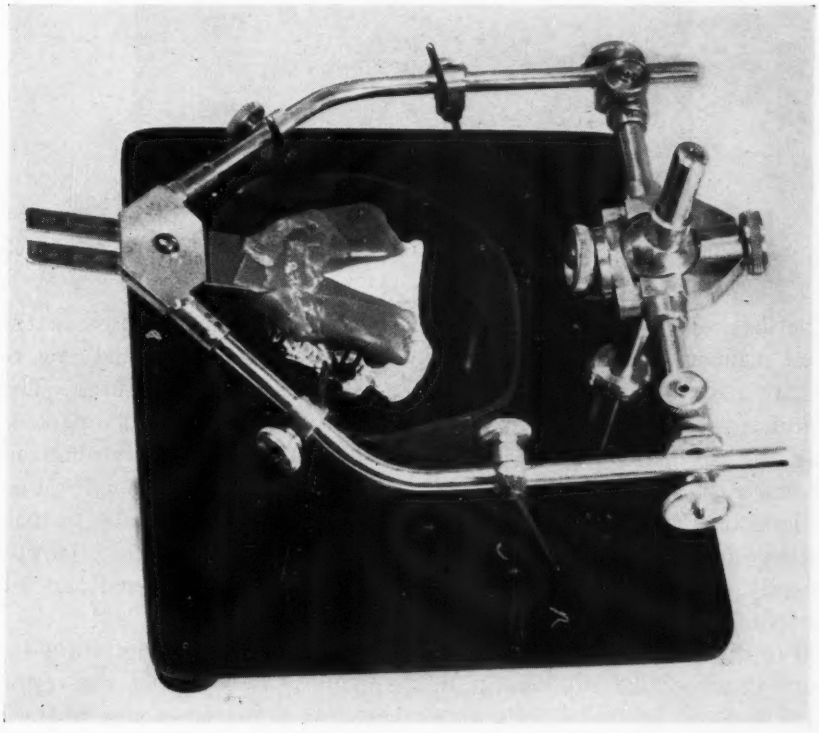


Fig. 14.—A new base is added. A boxing of carding wax surrounds the working cast. A large bowl of plaster is mixed and the contents poured into the boxing.

of plaster is mixed, and the contents poured into the boxing. A new base is mounted to the working cast on the platform. The sides are trimmed, and the working cast is oriented to the planes of this patient's skull.

ESTABLISHING THE VERTICAL DIMENSION

A satisfactory reference position for establishing the occlusion in such collapsed cases is the *physiologic rest position of the mandible.* This may be determined the same as for full dentures. The vertical dimension can be obtained by the Willis method, the Pleasure method with the calipers, the Sorenson method, or any other acceptable workable means. This dimension is arbitrarily obtained no matter what method is used.

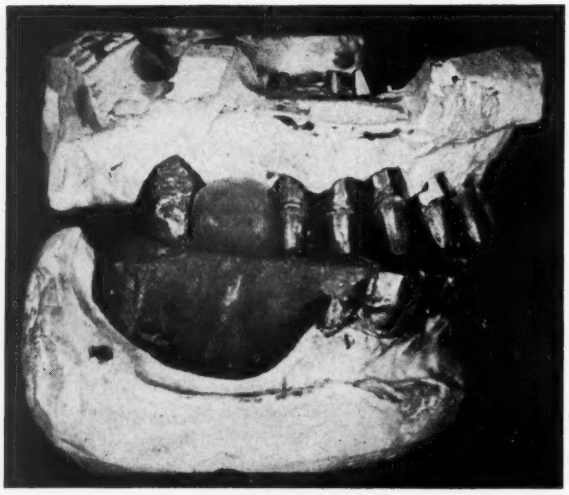


Fig. 15.—Occlusion rims are constructed. This is done the same way as for full dentures.

The lower teeth are prepared, and the working cast is poured in the conventional manner. Occlusion rims are constructed (Fig. 15), and jaw relation records are made with these rims in the same way as for full dentures. The casts are articulated on the articulator of your choice, with the base of the oriented upper working cast parallel to the top of the work bench. The posterior abutments are waxed and cast (Fig. 16*A*) and then tried in the patient's mouth (Fig. 17). Corrections are made to the individual's tolerance. Tests are made so that these restorations are within the limits of this patient's free-way space. Sometimes it is necessary to make a new master impression with the corrected and adjusted abutments in place, and remount it on the articulator.

All of the restorations are completed on the articulator (Fig. 16*B*) but it is necessary to make final adjustments in the mouth. In this case, the restorations consisted of fixed bridges in the upper jaw, and a precision attachment partial denture in the lower. Four porcelain jacket crowns closed up the spaces. Figs. 18*A*, 18*B*, 19*A*, and 19*B* illustrate the completed restorations. The prognosis

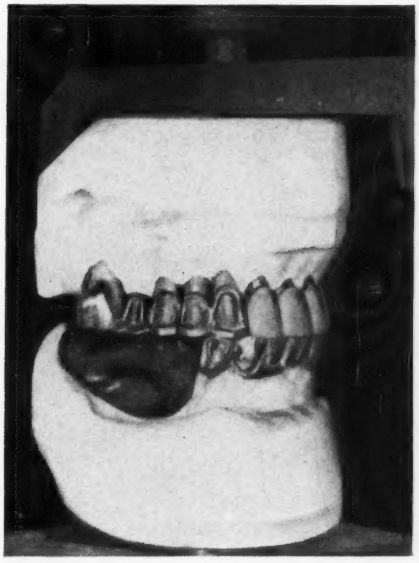


Fig. 16*A*.—Abutments and crowns are constructed on the articulator.

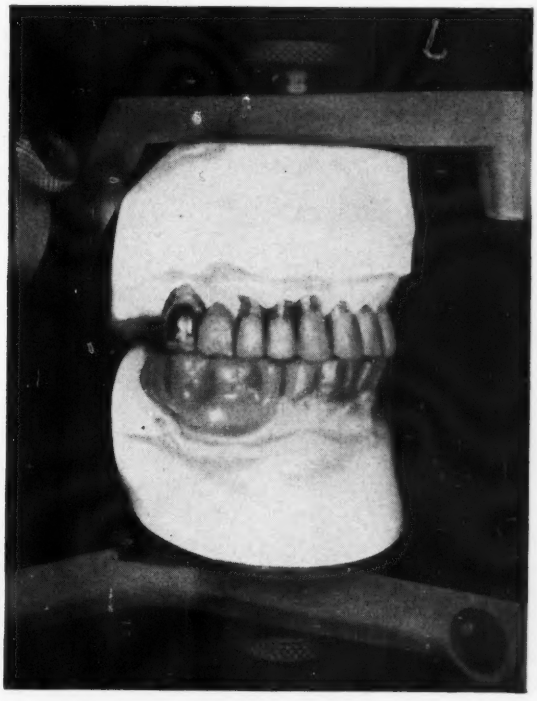


Fig. 16*B*.—The restorations are completed on the articulator. It is necessary to make final adjustments in the patient's mouth.

of patients treated in this manner is favorable. It was necessary to equilibrate the occlusion from time to time during the first few weeks.

Servicing of broken porcelain jacket crowns, remaking discolored plastic restorations, spot grinding high unworn interferences, and possible remakes in extensive restorative dentistry should always be considered a part of the treatment plan. It is the practitioner's prerogative whether he wishes to charge a fee for this service or not.

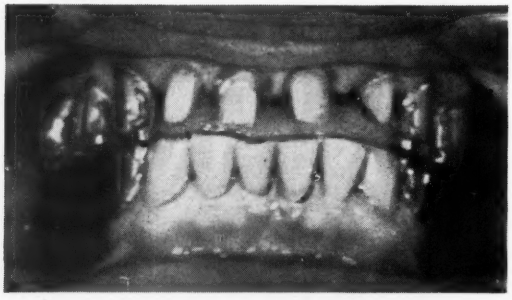


Fig. 17.—Corrections are made to the individual's tolerance. Tests are made so that the restorations are within the limits of this patient's free-way space.

A.

B

Fig. 18*A*.—Same patient as in Fig. 11, right side.

Fig. 18*B*.—Left side of completed restorations.

A.

B

Fig. 19*A*.—Same patient as Fig. 11. The badly spaced anterior teeth received porcelain jacket crowns.

Fig. 19*B*.—Lingual view of the completed restorations.

PROCEDURES IN RESTORING AN ENTIRE DENTITION POSSESSING A SATISFACTORY OCCLUSAL RELATIONSHIP

Despite the fact that cuspal interdigitation is variable, centric occlusion between some opposing teeth can be used as reference positions *when these teeth are responsible for a stable, comfortable, and functional occlusion.* These teeth must be

Fig. 20*A*.—A patient with an existing comfortable occlusion but requiring rehabilitation

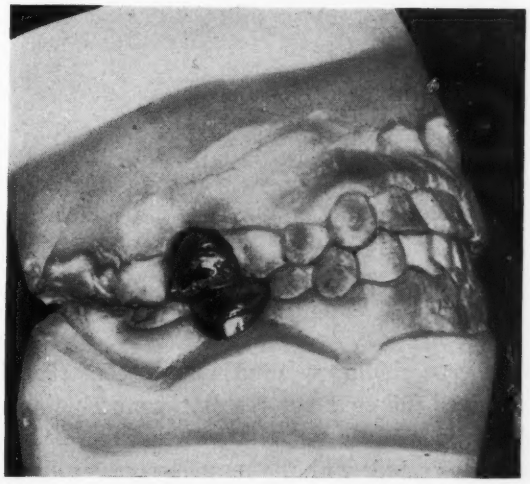


Fig. 20*B*.—Same patient as in Fig. 20*A*. All the first molars received full coverage restorations to occlude with the remaining uncut teeth which acted as guides in maintaining the satisfactory occlusion.

in harmony with the nondamaging mandibular movements. Figs. 20*A* and 20*B* illustrate the case of a young man of 21 years who was rapidly wearing down the

soft mottled enamel on the occlusal surfaces of all his posterior teeth. Porcelain jackets on the unattractive anterior teeth only would fracture as the occlusal surfaces of the molars and bicuspids wore down. In a case like this, *it should not be necessary to cut all the teeth in one jaw first, thus destroying the existing comfortable tooth contact, and then seek to locate that functional relationship all over again by guesswork.* Where no appreciable change in cuspal interdigitation has occurred, the occluding teeth can act as *guides* in maintaining this satisfactory re-

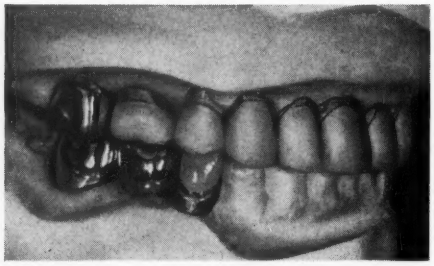


Fig. 21*A*.—Same patient as in Figs. 20*A* and 20*B*. The remaining teeth received veneer and porcelain crowns to occlude with the previously covered first molars.

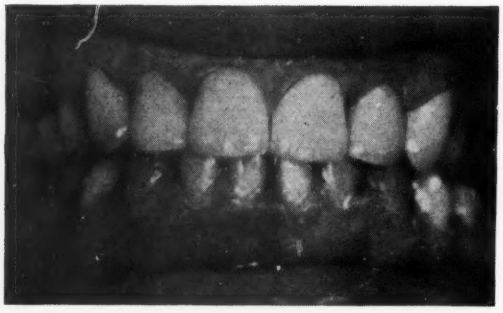


Fig. 21*B*.—After rehabilitation.

lationship while the other occluding restorations are constructed. In this patient, all the first molars received full coverage restorations occluding with the "guiding" uncut teeth (Fig. 20*B*). Then the remaining teeth were covered with veneer and porcelain jacket crowns to occlude with the completed restorations on the first molars (Figs. 21*A* and 21*B*). The lower anterior teeth were not covered at all. Wherever possible, I avoid cutting and covering lower anterior teeth. I believe that human hands can never reproduce these small delicate teeth accurately by full coverage restorations, and give satisfactory esthetic results with healthy pulps. Some of the mottled enamel on the labial surfaces of these lower incisors was ground and polished off. The prognosis of patients treated in this manner is favorable.

Sometimes only one side of teeth present can be used as "guides." They need not always be posterior teeth. There are occasions when opposing canine teeth can be used as "guides." The procedure of unilateral restorations as "guides" may produce some difficulties in the maintenance of the patient's satisfactory occlusion. These are difficulties one would not encounter in the previously described bilateral tooth case. A one-sided occlusal stop, however, is better than none and it should be utilized.

Some cases requiring restorations involving the entire occlusion are those aggravated by periodontal conditions. It is imperative that all gingival disturbances be corrected and loose unsatisfactory teeth be removed. It would be a shame to insert elaborate, time consuming, and expensive restorations over problematical and questionable teeth. When many teeth have lost their supporting structure, splinting them together is the procedure often recommended. When loose teeth are splinted to some strong teeth, it is always a question whether the loose teeth become stronger or the strong teeth become loose. If splinting is decided upon, then certain considerations should be given to esthetics, to cleanliness, and to stimulation of the interproximal tissues. With these considerations in mind, the splinting of teeth with porcelain jacket crowns is not a practical undertaking (Fig. 22). Splinting with porcelain crowns necessitates the construction of gold copings which are soldered together, and upon which the porcelain jackets are made. Each soldering connection of the splint is at the gingival border of each tooth, and

Fig. 22.—Roentgenogram of splinted porcelain jacket crowns. The soldering connection of each tooth is in the interproximal space and prevents access for stimulation and cleanliness.

it closes up each interproximal space. As a result, the gum tissue soon takes on a bluish-red appearance, and the papillae become swollen and loose. If you believe in splinting, then do it with veneer crowns. The solder joints of these restorations are at the incisal edges, and the interproximal areas are accessible for cleanliness and stimulation. The patient should be advised, however, that gold edges will be visible and the plastic may change color. Often, the anatomic forms of the teeth splinted are altered and appear bulky.

SUMMARY

Extensive restorative dentistry or so-called mouth rehabilitation is merely a correlation of required and indicated dental restorations and treatment for a particular patient, the procedures of which are governed and controlled by that patient's limitations. No set rule can be recommended which will apply to the treatment of all patients. The correct and proper method of approach depends upon the foresight, the ability, and practical experience of the practitioner and his technician. We must be mindful, always, that some mouths are better off if left alone.

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FUNCTIONAL ASPECTS OF COMPLETE MOUTH REHABILITATION

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A BIOLOGIC AND FUNCTIONAL approach to restorative dentistry is essential for the satisfactory performance and fulfillment of those requisites basic to prosthodontics. Accordingly, the masticatory organ must be considered as a functional, consolidated unit, with proper attention being directed to all the elements that comprise this unit. All functional factors are interrelated, and proper regard for each aspect is essential, if the restoration and maintenance of the health of the entire functioning mechanism is to be a realization. Consequently, a comprehensive study and practical approach must be directed toward the interrelation of the teeth and their supporting periodontal structures, the myofunctional aspects of mastication, the intricacies of the temporomandibular joint mechanisms, and the functional aspects of vertical dimension, free-way space, centric relation, and centric occlusion.

The objective of complete mouth rehabilitation is the reconstruction, restoration, and maintenance of the health of the entire oral mechanism. The accomplishment of this goal requires an understanding and utilization of all available dynamic potentials.

This is opposed to a static approach, which recognizes the existence of the various functional elements of mastication, but fails to integrate all these components into a single structural unit. For example, the technique of rehabilitation through simple occlusal reconstruction, wherein each tooth is considered as an individual entity, and wherein the over-all pattern of mastication is neglected, is a static approach. The importance of the functional factors of proper vertical dimension, adequate intermaxillary free-way space, and balanced functional occlusion are disregarded, and, as a result, a true restoration is not achieved. This type of rehabilitative procedure does not consider the important physiologic factors basic to mastication, and, consequently, the procedures constitute a mere mechanical reconstruction. Thus the correction of those elements responsible for the masticatory breakdown remains unchanged, and the restoration of the dental organ to a true state of functional efficiency is not realized. Complete mouth rehabilitation is a dynamic, functional problem, and embodies the correlation and integration of all the component parts into one functioning unit. The aim and endeavor, therefore, must be reconstruction and rehabilitation of the whole, satisfying all the related factors.

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This article is limited to a discussion of the theoretical and practical concepts basic to complete mouth rehabilitation. The science of complete mouth rehabilitation rests upon three proved and accepted fundamentals: namely, the existence of a physiologic rest position of the mandible, which is a constant; the recognition of a variable vertical dimension; and, finally, the acceptance of a dynamic, functional centric occlusion. These principles have been basic in the development of the myofunctional concept of mastication and have furthered the development of the physiologic approach to occlusion.

PHYSIOLOGIC REST POSITION

Investigations have proved that the physiologic rest position of the mandible is fixed and constant,[1] and that it does not vary with age or with the presence or absence of teeth. Thus, it is a reliable starting point for the design of a physiologically correct occlusion. The physiologic rest position is a relaxed, normal, physiologically balanced maxillomandibular positioning, wherein antagonizing tensions that exist during function are in a state of equilibrium. All functional movements of the mandible begin and end at this rest position. From a practical point of view, techniques have been devised whereby this position can be recorded, registered, and maintained.

VERTICAL DIMENSION

The correct vertical dimension can best be described as the vertical height of the face, determined by muscular relationships, utilizing the physiologic rest position of the mandible as the guiding factor. Therefore, a practical working knowledge of the physiologic rest position is essential in the determination of the correct vertical dimension. It is particularly significant that since the mandible assumes its positional relationship to the skull early in life,[2] the vertical dimension of the face is necessarily established at that time and remains proportionately constant throughout life. Therefore, treatment of a "closed bite" is not designed to increase the vertical dimension or to "raise the bite," inasmuch as this would infer an increase beyond the normal, but is intended as a means of restoring the amount of vertical dimension of occlusion that has been lost.[3] In the rehabilitative procedures, the restored masticatory organ must be reconstructed within the limits of the physiologic rest position, with sufficient allowance being made for a functional intermaxillary free-way space. The free-way space varies according to the individual problems of the patient and is dependent upon various factors: the age of the patient, the amount of lost vertical dimension, the condition of the periodontium, and the extent of the malocclusion, etc.

The physiologic rest position is the starting point of the biting action. The free-way space is that space existing between the maxillary and mandibular teeth when the mandible is at the physiologic rest position. Therefore, as the vertical dimension decreases as a result of loss of teeth, or wear of teeth, the size of the free-way space between the mandibular and the maxillary teeth will increase. Consequently, the mandible must travel a greater than normal distance to make positive

contact with the maxilla, resulting in abnormal, unbalanced forces being constantly activated. Conversely, if the physical contact position of the mandible is at the rest position, or if it is in a functioning position beyond the rest position, it would mean that no allowance for free-way space between the mandibular and maxillary teeth exists. Translated into action, this would signify that the mandible must travel to an excessive point beyond the rest position, during the process of mastication, resulting in abnormal tension on the musculature and undue forces upon the dentition and the supporting structures. The strain and pull on the muscles might produce pain, discomfort, and constant tension. It has been observed in dentulous as well as in edentulous patients that, after a period of time, the muscles will return to their normal length, but only after a sacrifice has been made through the development of detrimental changes in the oral cavity. The return of the strained musculature to its normal length will be effected by a resorption of the underlying alveolus, resulting in possible loosening and migration of teeth. In other words, the muscles involved will resist this constant strain and, as a result, will force the dentition into a new arrangement which permits the musculature to assume a rest position that is comfortable, as well as to develop a sufficient amount of free-way space for function.

CENTRIC OCCLUSION

The position that the mandible assumes when the teeth are brought into occlusion may be termed the physical contact position. This position is determined by the interrelationship of the respective cusps and inclined planes of the opposing teeth. In a normal occlusal state, the physical contact position will correspond with the centric position of the mandible. It is the midway point in the centric cycle, which consists of the movement of the mandible from the physiologic rest position to the tooth contact position, and the return of the mandible to the physiologic rest position. Therefore, centric occlusion may be defined as the occlusal interrelationship of the mandibular to the maxillary teeth, when the mandible is in its utmost state of closure.

An occlusion can be considered to be in a state of correct centric occlusion when the opposing teeth enter into a state of proper intercuspation at an acceptable vertical height, with adequate allowance for free-way space, and wherein no condylar displacement occurs when the mandible travels from its position of centric relation to centric occlusion. A state of harmony must exist between the centric relation of the mandible and the centric occlusion of the teeth. In this ideal state, the teeth, the articulation, and the supporting musculature are in a perfect state of reciprocal balance. Consequently, all functional excursive movements are performed efficiently with coordinated and balanced synchronization. Deviations from this functional pattern will result in a disharmonius relationship between the teeth in function, the temporomandibular joint relationships, and the supporting musculature. An abnormal path of closure will be in operation as a result of this malfunctioning relationship. It will be observed that if a functional analysis of the occlusion is made, mandibular displacement will occur, and the mandible will assume an abnormal or accommodating position. It therefore follows that all

subsequent mandibular movements from this eccentric position will of necessity be abnormal. Thus, the entire pattern of mastication will lack proper coordination or harmony.

Fig. 1.—Laminagraph of the right temporomandibular joint at the rest position before treatment. Note the excessive free-way space.

Fig. 2.—Laminagraph of the right temporomandibular joint at the physical contact position before treatment.

ROENTGENOGRAPHIC STUDIES

In order to study and determine mandibulocondylar changes that occur when the mandible assumes the various functional positions common to it, I have adapted roentgenographic techniques for obtaining laminagraphs and cephalographs, which I use routinely in my practice. The laminagraphic technique affords a means of comparative study of mandibular positions and their respective, corresponding condyle relationships (Figs. 1, 2, and 3). Exposures are made at the original tooth contact position, the physiologic rest position, the wide-open position, and the proposed restorative functional position. By a double exposure technique, laminagraphic superimpositions are secured of the physical contact position

and the physiologic rest position of the mandible (Fig. 4). Laminagraphy has proved a valuable adjunct in temporomandibular joint radiography, for it offers a means of securing undistorted, clear pictures of these joints. These studies enable one to detect abnormalities of the articulating surfaces, deviations in the functional pattern, and any gross pathology. It enables the dentist to gain a per-

Fig. 3.—Laminagraph of the right temporomandibular joint at the wide-open position before treatment. Note the extent of motion.

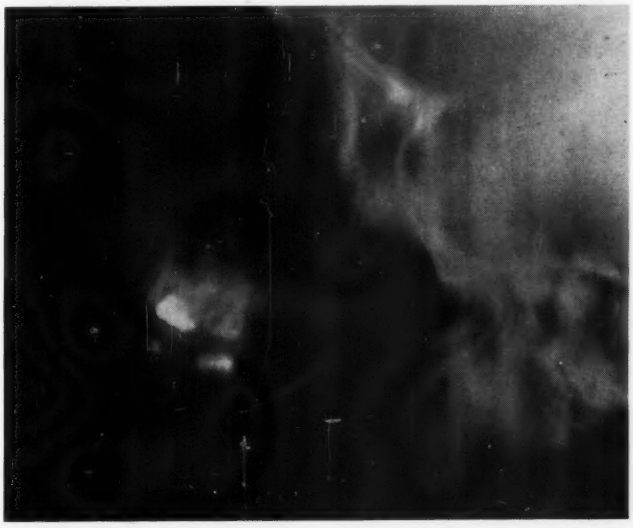

Fig. 4.—A superimposition of laminagraphs of the right temporomandibular joint, obtained by the double exposure technique, at both the physical contact and the physiologic rest positions. Note the condylar displacement.

spective of the path of the condyle during closure, noting its displacement, if any, as the mandible travels from its physiologic rest position to its physical contact position. It further enables the operator to observe the possibilities of eliminating and correcting this displacement by means of comparative study of the mandibular positions (Figs. 5, 6, and 7). The size, shape, form of the condylar head and

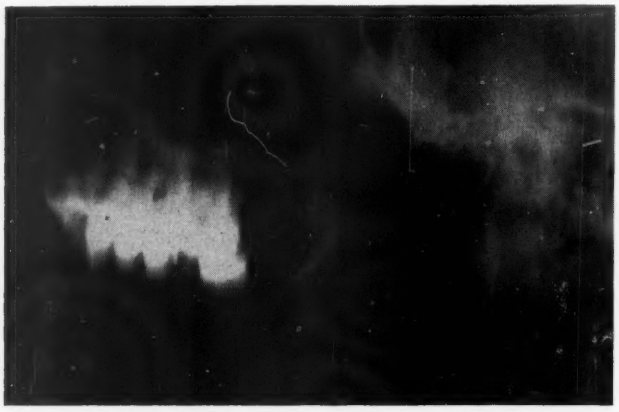

Fig. 5.—Laminagraph of the right temporomandibular joint at the mandibular rest position after treatment.

Fig. 6.—Laminagraph of the right temporomandibular joint at the physical contact position after treatment.

neck, the fossa, and the articular tubercle, together with variances in the condylar free-way space, may be observed in the superimposition of the physical contact position and the physiologic rest position. Deviations and changes from the natural will be observed in accordance with the particular type of occlusal anomaly. Thus, this affords an opportunity of observing the existing condyle positions, and offers a radiographic blueprint of the positions that the condyles will assume at the completion of the restorative work.

Another important diagnostic aid in the recording and study of the mandibular position is the cephalometer. The technique consists of positioning the head in a fixed reference frame and of standardizing all the component factors: the central ray, the position of the head, and the x-ray film. Roentgenograms and tracings of the successive positions of the mandible may then be obtained for accurate comparative study. Exposures are obtained at the physical contact position, the physiologic rest position, and the proposed vertical opening. The resulting cephalograms then may be superimposed, one upon the other, and a composite tracing

Fig. 7.—A laminagraphic study of the right temporomandibular joint. By a double exposure technique, laminagraphs made at the physical contact position and the physiologic rest position were superimposed. Note the elimination of the displacement of the condyle.

of the three mandibular positions can be obtained. This offers a simple and concise means for comparative study, and affords a blueprint of the exact amount of existing free-way space. The possibilities of utilizing this potential free-way space in the rehabilitative process can be noted, and it is possible to observe the functional free-way space that will exist after rehabilitation. These methods of study are invaluable and act as a guiding factor in the diagnosis and treatment planning by revealing the possibilities as well as the physiologic limitations of treatment.

FUNCTIONAL ANALYSIS OF OCCLUSION

A functional analysis of occlusion is pertinent to the formulation of a proper plan of treatment for complete mouth rehabilitation. It must include: (1) The determination of the proper vertical height by utilizing the physiologic rest position of the mandible as a guide, and noting the existing functional free-way space. (2) An examination and study of the path of closure from rest position to the physical contact position of the teeth, noting whether condyle displacement occurs. (3) The effects of the occlusal pattern upon the periodontal structures. (4) A study of the temporomandibular joint positions relative to the occlusal pattern by means of roentgenographic evaluation.

CENTRIC RELATION

Centric relation is a maxillomandibular relationship which is dependent upon myofunctional conditions. Centric relation is concerned with both the horizontal and the vertical relationships of the mandible to the maxilla, and this position and relationship may be recorded, registered, and maintained. With this myofunctional registration as a guide, the pattern of centric occlusion may be established. From an understanding of the physiology of mastication, it is obvious that a dynamic balance of the muscles involved and of the forces and stresses being constantly activated is essential if the true centric relationship of the mandible is to be recorded and registered. Centric relation may be defined as that position of the mandible in relation to the maxilla, when the condyles are properly balanced in the glenoid fossae as a result of proper muscular balance.[5] It is generally agreed that centric relation is indicated by the apex of the Gothic arch tracing, which is a recording of mandibular movements in the certain paths of function. This statement is true in essence, but modification of this concept is necessary, for it is possible to obtain a Gothic arch tracing with instrumentation that does not take into account the functional aspects of mastication, and, hence, the apex of the Gothic arch tracing does not represent the true functional relationship. This position may represent a balance of the muscles operating in only one plane. In order for a Gothic arch tracing to be representative of the true functional relationships of the mandible to the maxilla, a functional balance of the forces constantly operating in both the horizontal and vertical planes must be obtained. If the centric relationship that is recorded does not reflect a true balance of the muscles and forces involved, then functional requirements will not be satisfied, and the established centric position and occlusal pattern will not represent a true functional occlusion.

In order to record a centric relationship which embodies a balance of the vertical and horizontal operating forces, a procedure based upon physiologic concepts must be utilized. I believe that the most accurate method, and one that comes closest to approaching the physiologic balance of the stresses and forces exerted by the muscles, is one which is based upon a pressure technique. The application of a light pressure, I have concluded, is the most precise and accurate technique for simulating the resiliency of the tissues and muscles functioning in the oral cavity. I use a modified pressure-bearing instrument to record a functional centric relation. Utilization of a light pressure is desired to properly equalize and balance the forces always present.

The ideas expressed regarding the complex field of functional occlusion are based on practical experience. In order to accomplish complete mouth rehabilitation, it is essential to restore the entire masticatory apparatus to a state of health and efficiency, recreating an environment in which the teeth, the supporting tissues, the musculature, and the temporomandibular joints function harmoniously. These basic concepts are of utmost importance, but they must be correlated with sound operative and periodontal procedures. A systematic approach to the operative and periodontic phases of the rehabilitative process must be formulated. The

tissues must be restored to a state of health, thus stabilizing the fundamental bony and soft tissue framework, and making possible a more favorable prognosis. The type of restoration best suited to provide functional efficiency must be determined. I prefer to use full coverage of teeth wherever possible, employing individual units or splintage as indicated. Operative procedures must be exacting and precise, and the completed restorations must be mechanically perfect and biologically sound, so that the completed restorations will be a physiologic factor in the maintenance of the health of the dental organ, rather than a pathogenic entity.

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RESTORATION OF THE EFFECTIVELY TREATED PULPLESS TOOTH

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ALTHOUGH INNUMERABLE contributions to the literature have been made concerning various phases of endodontics and also on the many restorative procedures and materials in operative dentistry, very few publications devoted to correlation of the two subjects are available. Certainly the pulpless tooth cannot be maintained in the mouth without effective endodontic treatment followed by equally effective restorative procedures. The purpose of this article, following a brief discussion of the present status of endodontics, is to discuss some of the recent developments in dental materials which are available for the restoration of the pulpless tooth.

CURRENT ENDODONTIC PROCEDURES

During the past ten years, one could not have had even the slightest interest and activity in the treating of pulpally involved teeth without having been aware of the tremendous and persistent progress which has been and is being accomplished in the field of endodontics. On the basis of the present level of endodontic effectiveness, it is granted that there was quite a need for improvement ten years ago. The progress, however, which has been made throughout those years could be cited with interest. Examples of only a small part of that and now recognized as routine endodontic adjuncts are:

1. The improvement in pharmacologic remedies which are used to assist the mechanical cleansing of the canal in gaining a sterile condition in preoperatively infected canals.
2. The reliable determination of the readiness of the root canal for filling through the use of carefully directed culture tests for the absence of pathogenic organisms in the canal.
3. The development of effective techniques for the obliteration of the root canal space including the increased use and efficacy of silver points where indicated.
4. The refutation of the previously supposed "validity" of the focal infection theory by a reappraisal on a statistically valid basis of that theory.

Space does not permit a complete discussion of all of the progress which has been made, but it is imperative to give deserved credit to the healthy thinking and activity which is evidenced by the development on the part of numerous individuals and groups of the large number of varied advocated endodontic procedures, tech-

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niques, and pharmacologic remedies which are successful in obtaining the same result—the maintenance of the pulpless tooth in the mouth as a healthy unit of mastication.

RESTORATIVE PROCEDURES

Investigators in the field of dental materials have likewise been progressive through research and development. Their advancements and developments are available, and are utilized to re-establish the complete functioning of the pulpless tooth after the completion of that kind of endodontic treatment which knowledge and experience provide the utmost confidence in its success. Regardless of the knowledge of therapeutics, and the operative skill which the endodontist may employ to obtain a sterile canal, and to obliterate completely the space of the same, a wider knowledge, vision, and scope are necessary in order to return the tooth to a functioning entity in the patient's dentition. It is necessary, and it is fortunate that utilization can be made of the recent and current developments in dental materials to accomplish that objective. Following is a discussion of some of the recent developments in dental materials which are of more frequent or routine value in the restoration of the crowns of the pulpless teeth subsequent to endodontic treatment.

Fig. 1

Fig. 2

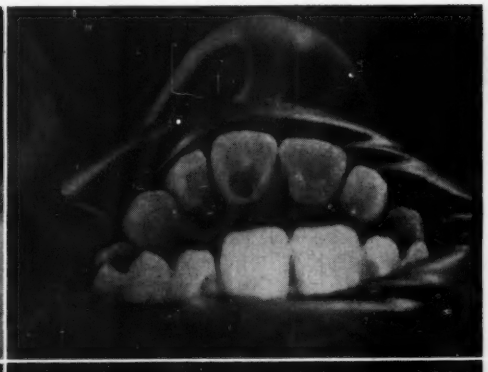

Fig. 3

Fig. 4

Fig. 1.—Coronal excess of root canal filling.
Fig. 2.—Coronal excess removed to the entrance of the root canal.
Fig. 3.—The cement base is placed.
Fig. 4.—Restoration of the lingual opening with a self-curing resin.

AUTORESINS

Although the gaining of direct access to any root canal by way of a lingual opening necessitates only a subsequent comparatively minute restoration, the frequency of the use of the lingual opening elevates the importance of the necessity for its most effective restoration after endodontic treatment has been completed.

Unfortunately, secondary discoloration of the crowns of pulpless teeth *can* occur with embarrassing frequency. One of the causes of this is failure to remove completely pulpal tissue from the crown of the tooth. That portion of the pulp tissue contained within the pulp horns and the remainder of the incisal area of the pulp chamber can readily be overlooked, unless an awareness of its presence is utilized to overcome the difficulty of its detection, and then to remove it. Another cause of discoloration is the failure, following the filling of the canal (Fig. 1), and before restoring the cavity, to remove entirely the canal filling material and any other discoloring material from the pulp chamber (Fig. 2). With the cavity thus cleaned, the placing of a cement lining of a shade compatible with the shade of the tooth (Fig. 3), followed by the placing in the cavity of a restorative material of equally agreeable shade (Fig. 4), will complete a procedure which will do much, but not all, to minimize subsequent crown discoloration. The peril of enthetic discoloration remains but a discussion of it, and its treatment is not within the scope of this paper.

Silicate cement with its high solubility characteristic and amalgam with its discoloring disadvantage are frequently used to restore the lingual opening. The advent of the self-curing or autoresin initially showed promise of its becoming an ideal restorative material in types of cavities where indicated. Clinical usage and investigation, however, in the dental materials laboratories demonstrated certain disadvantages in the material. Its low degree of hardness, its dimensional change, and its low modulus of elasticity were responsible for diminishing the original enthusiasm for its general use. In the lingual opening, because of little or no occlusal stress, hardness and a high modulus of elasticity are not within the realm of requirements for the restorative material to be used. Its high degree of insolubility, and its more favorable color characteristic lend to the advantage of the use of the self-curing resin over the use of silicate or amalgam in the lingual opening. The development by Nealon[1] of a nonpressure neutralizing or contraction compensating technique, is considered effective in overcoming the dimensional change or contraction factor in the self-curing resin. Fig. 4 shows a self-curing resin restoration placed in a lingual opening subsequent to endodontic treatment.

GOLD INLAYS

In the use of gold inlays to restore lost tooth structure of the crowns of pulpless teeth, we are again able to benefit from continued developments in investment materials, inlay golds, and casting techniques. Formerly, empiric procedures employing materials of inconsistent and inadequate compensatory behavior resulted in inlay castings, the fit and use of which were only in accordance with the conscience and integrity of the operator. Due primarily to the activity of the American

Dental Association Research Commission in the United States Bureau of Standards, investigation into the behavior of casting materials has resulted in the establishment of specifications[2] for those materials, which together with an increase of knowledge in the technique of their use, enables us today to produce castings on a scientific basis, and of definitely improved fit.

Fig. 5.—Silver point-gutta-percha canal fillings in an upper first bicuspid.

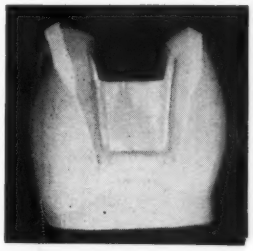

Fig. 6.—Cavity preparation for a mesio-occlusal-distal inlay restoration of a pulpless bicuspid.

Fig. 5 is a radiograph of the filled canals of an upper first bicuspid, with caries of the mesial, occlusal, and distal surfaces. Fig. 6 is a model of a cavity preparation for a mesio-occlusal-distal inlay restoration of that bicuspid. It varies *slightly* from that used in the vital pulp cases. Due to the fact that the intercuspal tooth substance has been lost as a result of caries and mechanical removal to permit direct access to the root canals, and also because of eventual increased brittleness in the pulpless tooth, the cusps must be supported and strengthened by capping them with gold in the inlay. To add further to this strengthening, an exaggerated or inverted bevel placed on the cavosurface angle of each cusp provides a gripping together of the lobes to resist the splitting action of mastication. The internal axial and pulpal walls in clinical cases are formed by a cement base. Definite and [illegible] cervical seats, likewise, strengthen the tooth by sharing the occlusal stress upon the inlay which is transmitted to, and dissipated through, those cervical seats. Reproduction in the wax pattern of the definite cervical bevels of the preparation assures the operator, upon examination of the completed wax pattern, that those margins have been covered.

The wax pattern for this restoration was carved in the direct method, and the the casting was made using a present-day compensatory effective investment, and with a careful burn-out and casting technique. Fig. 7 shows the completed inlay providing adequate support to the previously weakened buccal and lingual lobes.

Fig. 7.—Gold inlay restoration.

AMALGAM

Routine mouth examinations impress upon the dentist the fact that dental amalgam is the restorative material most frequently used in dentistry. Tooth destruction of such extent as to necessitate endodontic therapy is also quite often of such extent that the resulting undercutting militates against the use of a gold inlay as the subsequent restoration, and hence there exists a frequency of the use of dental amalgam in the restoration of the pulpless tooth. Dental amalgam is an excellent restorative material when handled properly, with a meticulous technique, and with a thorough knowledge of its physical properties as provided by recent and current research. When abused, however, as with empiric techniques, it will lead the tooth down a path to irreparable coronal damage.

As a result of all-inclusive investigations, tests, and experiments, and in order to obtain the highest degree of uniformity and effectiveness in all dental amalgams, the Research Commission in the Bureau of Standards has also established specifications[2] for this material. The portion of the specifications of most interest to the dentist is the general requirements which in essence are:

"Amalgams shall possess the following features, known as satisfactory working qualities:

1. Smooth plastic amalgamation within three minutes.
2. Susceptibility to carving for at least fifteen minutes, after amalgamation.
3. Susceptibility to receiving and retaining a polish twenty-four hours after amalgamation."[2]

The manufacturers of most dental alloys comply with these specifications, and hence the profession is provided with only very few definitely inferior dental alloys.

Healey and Phillips[3] recently reported on the results of a study of the causes of failure of 1,521 defective amalgam restorations. The main factors which contributed to the failures were judged to be: (1) improper cavity preparation, which was the causative factor in 56 per cent of all of the failures examined; and (2) faulty manipulation of the amalgam, or its contamination at the time of its insertion, in 40 per cent of the failures.

It is apparent from this study that the clinical success of amalgam restorations is dependent upon many factors, 96 per cent of which could have been controlled by the dentist. Careful cavity preparation, proper manipulation of the amalgam, and restoration of normal anatomic contour can reduce to a minimum clinical failure of amalgam.

Fig. 8.—Canal fillings in two adjacent upper bicuspids.

Fig. 9.—Amalgam restorations placed.

Fig. 8 is a radiograph of canal fillings in two upper bicuspids, the endodontic treatment of which included intracanal poly-antibiotic therapy, the determination of the readiness of the canals for filling by negative culture tests, and the lateral condensation method employing silver points for the actual filling of the canals. In Fig. 9, amalgam restorations have been placed in cavity preparations utilizing the fundamental principles of cavity preparation for amalgam, including the provision for bulk of restorative material to assure adequate strength in the restorations.

Polishing of the restorations adds to their esthetic appearance, and minimizes the possibility of later tarnish.

FRACTURED ANTERIOR TEETH

Recent refinements in plastic materials have resulted in an increase in permanency and esthetics in crown restorations made of those materials. Traumatic injury to anterior teeth resulting in pulpal involvements is frequently accompanied by extensive loss of coronal tooth substance. In some instances, when the pulp chamber is not large and the incisogingival extent of the fracture is not great, the tooth has sufficient strength to be restored with a jacket crown which requires no additional provision for strength in the prepared tooth. In many

Fig. 11.

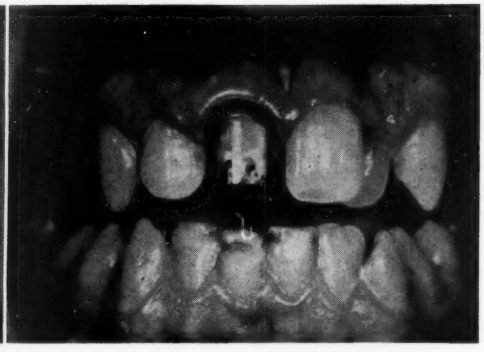

Fig. 10.

Fig. 10.—Extensive fracture of an individual tooth with a necrotic pulp.

Fig. 11.—A gold core and post cemented to place, and the completed jacket crown preparation.

cases, however, the tooth is weakened by a large pulp chamber, and its retentive features for a jacket crown are lessened by extensive incisogingival loss of tooth substance. Following completion of endodontic therapy in such teeth, the remaining portion of the crown can be strengthened by the use of a platinum, gold, and palladium alloy post cemented to place in the root canal, and to the incisal end of which post, a gold core has been cast to increase the incisogingival length of the jacket preparation. Fig. 10 shows the fracture of an individual tooth resulting in a necrotic pulp. Endodontic treatment was completed, and the canal was filled with gutta-percha and an antiseptic sealer advocated by Rickert.[4] Fig. 11 is a photograph of the completed jacket preparation with the post and gold core in place. To provide adequate retention, the post should extend into the canal a distance approximately equal to the length of the eventual jacket crown. It should extend out of the tooth in the incisal direction sufficiently to enable a firm gripping of it by the wax pattern for the core. The wax pattern, building up the incisal portion of the preparation, should surround the pulp chamber portion of the post, and pass partially around the canal portion of the post if possible. In Fig. 11, the completed preparation has sufficient incisogingival length to counteract any dislodging forward thrusts from occlusion upon the ultimate crown. Utilizing

necessary impressions, dies, and casts, a plastic jacket crown, Fig. 12, was fabricated and completed for the tooth. Fig. 13 is the postoperative roentgenogram.

Fig. 12.—The completed plastic jacket crown.

Fig. 13.—The postoperative entgenogram.

SUMMARY

As a result of progress through research and development, endodontic procedures are effective in returning the pulpless tooth to a state of health.

Inherent characteristics of the pulpless tooth, including brittleness and discoloring tendencies, and extensive diminution of coronal integrity due to the etiologic factors which necessitated the endodontic therapy, require specific considerations in constructing the restoration.

Effective restoration of the pulpless tooth subsequent to present day effective endodontic therapy is facilitated by the clinical application of recent developments in dental materials.

Acknowledgment is made to Roland Dykema for the jacket crown shown in Figs. 10, 11, 12, and 13.

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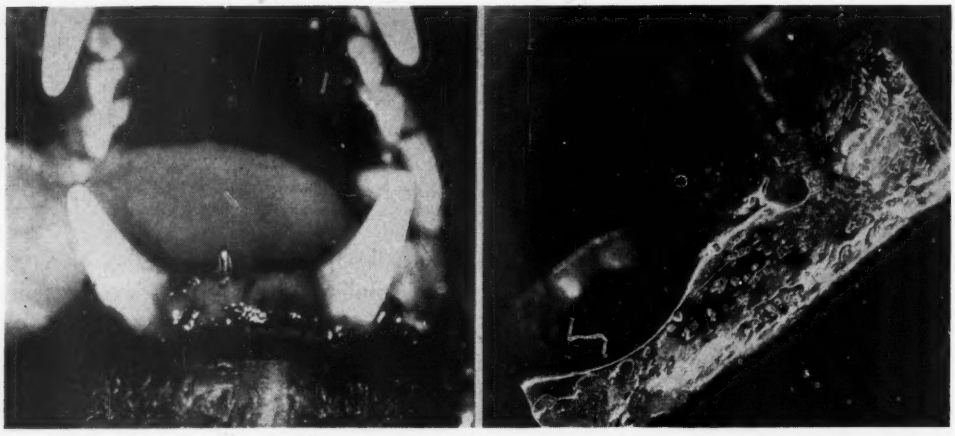
Indianapolis 2, Ind.

TISSUE REACTION TO VITALLIUM IMPLANTATION

CHARLES NEWMAN, D.D.S.,* AND GRANT VAN HUYSEN, D.D.S.**

Indianapolis, Ind.

THIS IS A REPORT of an investigation of the histologic reaction of the oral tissues of the dog to the insertion of chrome cobalt implantations. These Vitallium (surgical Vitallium No. 21) implantations were fastened to the bone of the edentulous portion of the mandible with a screw, and a post protruded through the covering mucous membrane into the oral cavity. The dog's lower incisor teeth were first removed, and the tissues were permitted to heal for two weeks. The bone was then uncovered and an impression of it was made. One week later, the Vitallium implantation made upon the cast of this impression was fastened to the bone with one small Vitallium screw. The post protruded through the oral mucosa (Fig. 1). The implantation remained in



A. *B.*

Fig. 1.—*A*, The Vitallium implantation sutured in position with the post protruding through the oral mucous membrane. *B*, The Vitallium implantation. Note the size of the hole for the screw.

the mouth for three months, when the dog was sacrificed, and the anterior part of the mandible of the dog containing the implantation was removed and placed in formalin fixative.

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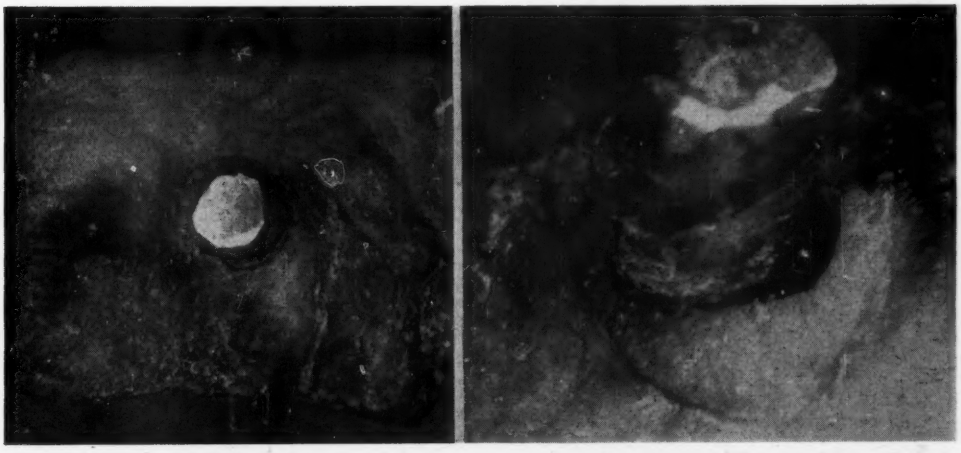
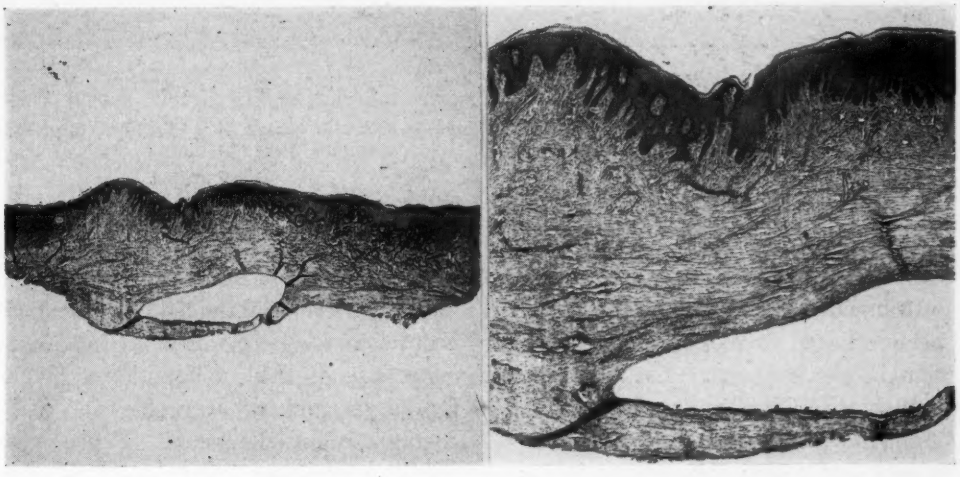
The Vitallium implantation was attached to the dog's mandible by means of a small Vitallium screw and sutured in place (Fig. 1). The hole in the metallic frame gives some idea of the relative size of the screw used to hold it to the bone. Fig. 2 shows the post with the arrangement of the mucosa around it after the dog was sacrificed, and after the fixed tissue containing the metal implantation was removed from the bone of the mandible. There is a crevice around one side of the post. There is some dark calculus-like material attached to the post in the vicinity of this crevice. One can also see swelling of the mucosa about the post. This swelling resembles, somewhat, the free gingiva seen about many human teeth.



A. *B.*

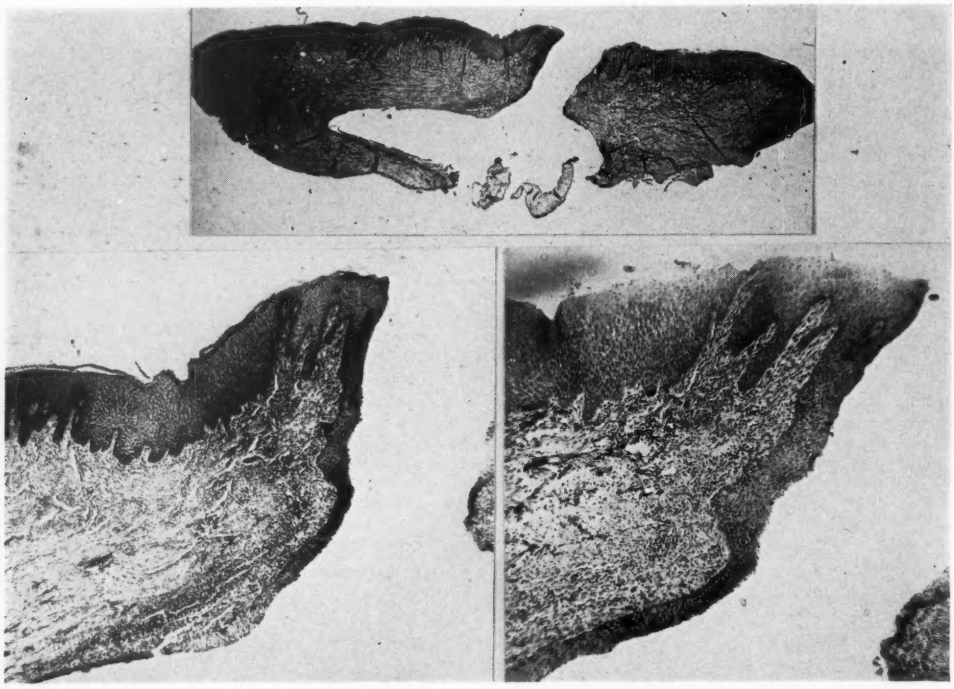
Fig. 2.—The excised tissue with the implantation post protruding through it. The tissue has been fixed in formalin. Note the crevice and the swelling of the mucous membrane around the post.



A. *B.*

Fig. 3.—Two magnifications of that part of the mucosa which covered the base of the Vitallium implantation. (*A*, Low magnification; *B*, high magnification.)

Fig. 3 shows low and high magnifications of the tissue which covered the implantation. The low magnification (left) shows that, although the implantation had been placed in contact with the bone, at the time of removal (three months later) a layer of connective tissue had formed between the bone and the metal. It was necessary to remove the implanted metal from the tissue before it could be processed for histologic sectioning, so it was impossible to tell how intimately the tissue enveloped the metal. The implantation slipped from its connective tissue envelope without difficulty. In other words, there was apparently

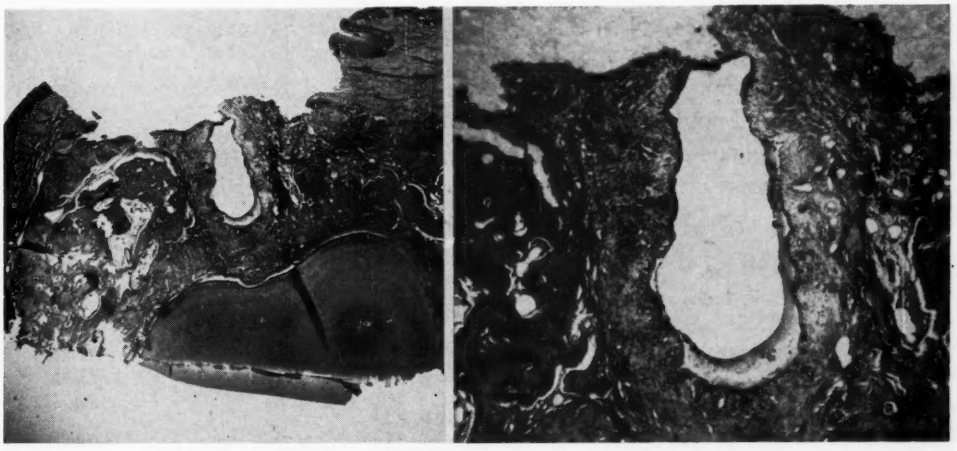


B *C*

Fig. 4.—Three views of that part of the mucosa through which the Vitallium implantation post protruded. (*A*, Low magnification; *B*, slightly higher magnification; *C*, highest magnification.)

no attachment between the metal and the enveloping connective tissue. Since the metal is impervious, one can assume that there would be no microscopic tissue attachment to it, and that the metal was no more than tightly held by the connective tissue envelope around it. There was no histologic evidence of inflammation in the connective tissue surrounding the base of the implantation. Under higher magnification, several layers of fibroblasts and collagen fibers can be seen, indicating new connective tissue formation around the metal. There were a very few polymorphonuclear leukocytes in this new tissue. Outside of the thin area of new connective tissue about the metal of the implantation, there was the usual thickness of normal connective tissue of the oral mucosa.

Fig. 4 shows three views of the tissue removed from the vicinity of the post that had protruded through the mucous membrane. The low magnification (*A*) shows the opening in the tissue through which the post extended into the mouth. The slightly higher magnification (*B*) demonstrates the fact that the epithelium of the crevice around the post extends from the oral cavity surface, down along the post, and well out over the surface of the metal. The highest magnification (*C*) shows the tissue at the left of the hole and the details of this epithelium lining the crevice between the post and the connective tissue. The connective tissue shows chronic low-grade inflammation. This inflammation will account for the swelling which was seen surrounding the post in Fig. 2.



A. *B.*

Fig. 5.—Histologic sections through the bone in which the Vitallium screw was placed. (*A*, Low magnification; *B*, high magnification.)

Fig. 5 shows two magnifications of the tissue surrounding the screw that was used to anchor the metal to the bone. Although the screw was inserted into the bone, a tissue membrane has appeared between the screw and the bone during the three months of the experiment. A critical examination of this membrane shows the presence of new connective tissue. There are many young fibroblasts in the area. There are considerable amounts of collagenous fibers, a few plasma cells, and capillaries in the area. There is some old blood in a few spaces in the new tissue, and some free fibrin in the fundus of the screw hole.

DISCUSSION

It is of interest to note that the metal implantation and screw placed in direct contact with the bone becomes separated from it by a dense layer of connective tissue during a period of three months. Since the screw becomes separated from the bone by a cushion of connective tissue, it may well be that the screw is an unnecessary part of the implantation procedure. Further study of implantations without screws is proposed.

This study shows that neither the connective tissue nor the epithelium can become attached to the type of metal used, but, despite this, the adaptation of the gingiva-like marginal tissue about the post is no worse than the gingiva in apposition to many natural teeth although it is not free of pathology. The situation depicted in this study is equal to similar natural arrangements of gingiva and tooth which are considered to be clinically and histologically within normal limits. Whether or not this condition remains the same or becomes worse can only be determined by experiments run over a longer period of time.

On the basis of this study, it would seem that the success of metallic implantations can be evaluated by the amount of clinically visible inflammation about the protruding pins.

CONCLUSIONS

1. Metallic implantations are held in place by a dense fibrous connective tissue envelope and not by rigid fixation to bone.
2. Metallic bone screws do not hold metallic implantations fixed to the bone.
3. The success or failure of metallic implantations depends upon the amount of inflammation about the pins which protrude through the mucous membrane.

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Erratum

On page 718 of the September, 1954, issue of the Journal, the name of Arthur H. Schmidt, 3700 Medical Group, Lackland Air Force Base, San Antonio, Texas, should be listed under *United States Air Force.*

Book Reviews

TOOTH FORM DRAWING AND CARVING. A MANUAL, By Russell C. Wheeler. Second Edition, 106 pages with 124 illustrations. Philadelphia and London, W. B. Saunders Co., 1954.

This manual is a flat, loose-leaf book, designed to assist in teaching laboratory procedure in the study of dental anatomy. It is intended to be used in conjunction with a textbook.

The human permanent dentition is considered. A discussion of the nomenclature used in describing teeth is followed by a brief, clear-cut description of each of the sixteen teeth. Drawings of five aspects of each tooth on graph paper ruled eight squares to the inch are accompanied by directions for making such tooth drawings in the laboratory. A table of measurements in millimeters for each tooth is given, along with illustrations of how each measurement was obtained.

Directions for tooth carving follow the drawings. Several teeth are first to be carved out of plaster blocks, three times natural size, using the previously made drawings as patterns. The plaster carvings are to be followed by natural size carvings of each tooth in hard wax or in Ivorine, complying with the measurements presented in the table.

The teeth carved natural size are then to be set in centric occlusion in a half jaw articulator. Accompanying the directions for setting up the teeth is a brief discussion of functional form of teeth, alignment, curvature of the dental arch, contact relations, occlusal contact, and intercusp relations.

The book is well illustrated. There are photographs of representative specimens of fourteen natural teeth (third molars omitted), and drawings of representative types of teeth: maxillary and mandibular incisors, canines, first premolars, and first molars.

The descriptions of the teeth are understandable and nonrepetitious. The illustrations give excellent visual assistance in obtaining a quick and correct grasp of tooth anatomy.

Ambiguities and errors are few. From the point of view of smooth, easy reading, a revision of sentence structure in several places would be helpful. In some instances the substitution of the words *cervical* and *occlusal (incisal)* for *above* and *below* (or vice versa) would avoid confusion. Clarification of the crown length measurement on the graph-paper drawing of the maxillary first molar seems to be needed. It is unfortunate that there were not included more detailed descriptions of the occlusal surfaces of the molar teeth.

Aside from a few such oversights, this manual looks like an excellent addition to the study aids in tooth anatomy, and it may be expected to be received enthusiastically by teachers and students alike in the fields of dentistry, dental hygiene and, dental laboratory technology.

DOROTHY PERMAR

ESSENTIALS OF REMOVABLE PARTIAL DENTURE PROSTHESIS, By Oliver C. Applegate, D.D.S., D.D.Sc. First Edition, 324 pages with 352 illustrations. Indexed. Philadelphia, W. B. Saunders Co., 1954. Price $10.00.

The purpose of this volume, as stated by the author, "is primarily to teach the principles of, to outline the planning for, and to chart efficient procedure in the design and construction of a removable dental prosthesis". To accomplish this broad objective, the book very excel-

lently (1) stresses the interdependence of successful oral services upon one another—one health service aiding in the maintenance of the others. Without a needed removable partial denture, periodontal, operative and fixed bridge procedures are rendered very temporary, and vice versa; (2) for the sake of unity and simplicity, confines coverage exclusively to the exposition of the clasp-retained restoration; (3) puts the required stress on the importance of physiology, since the success of an appliance with reference to long maintenance of function is dependent upon biologic response; (4) presents sound deductions as to the reaction of tissues to stresses; (5) furnishes illustrations which are quite clear and understandable; (6) uses large bold print to emphasize and summarize; (7) is a large book in keeping with the size of the subject covered; (8) emphasizes in the best way the true importance of the surveyor and the necessity for surveying; (9) outlines the necessity for careful preliminary examination and planning, a procedure which will actually prevent undesirable results from happening.

The book largely has a question and answer format. This reviewer believes that in this sort of composition the author must too generally presuppose what questions will arise in the readers' and students' minds, that there is needless repetition in the answering of questions which are similar, and that it is much more difficult to locate the exact reference information being sought. The descriptive essay type of text would have lent itself better to classroom teaching. Also, the volume might have greater universal acceptance if the author had shown less prejudice in favor of one certain type of clasp and had given, instead, a broad illustrative coverage of all types of clasps along with the pros and cons of the different metals used to provide clasping function. Further, since photographic cuts do not stand out as clearly and sharply defined as heroic, schematic line drawings, more use of the latter would have greatly clarified the various leverages which result in functioning partial dentures and would have added much toward a complete and more lucid coverage of removable partial denture designing.

Perhaps it should be borne in mind that the omission of material which this reader considers so pertinent may be justified on the basis that one volume cannot be expected to cover everything on the subject.

Since no other book even vaguely similar is available, it becomes a "must." The treatise is by far the most comprehensive on removable partial denture prosthesis furnished the dental profession for many years, and the author is to be highly commended for making the great effort and sacrifices to bring about this vast contribution.

VICTOR L STEFFEL

News and Notes

ANNOUNCEMENTS

The Greater New York Dental Meeting will be held Dec. 6 through 10, 1954, at the Hotel Statler.

The American Academy of Restorative Dentistry will meet Feb. 5 and 6, 1955, at the Conrad Hilton Hotel, Chicago, Ill.

Temple University School of Dentistry announces a postgraduate course in "Clinical Occlusion" Jan. 26 to 28, 1955, by Dr. Lewis Fox of South Norwalk, Conn. For further information write to Louis Herman, D.D.S., Director of Postgraduate Studies, Temple University School of Dentistry, at Broad above Allegheny Avenue, Philadelphia 40, Pa.

The School of Dentistry, University of Pennsylvania announces several postgraduate courses of interest to prosthodontists.

P.G. 3.—Complete Denture Prosthesis, M. M. DeVan, March 7 to 12, 1955.

P.G. 4.—Complete Denture Prosthesis Seminar, M. M. DeVan, May 12, 1955. (Open to dentists who have completed P.G. 3)

P.G. 5.—Complete Denture Prosthesis, Victor Lucia, March 28 to April 2, 1955.

P.G. 6.—Crown and Bridge Prosthesis, Charles B. Sceia, Feb. 14 to 19, 1955.

P.G. 7.—Clinical Application of the Principles of Crown and Bridge Service, Ernest B. Nuttall, April 11 to 16, 1955.

P.G. 21.—Partial Dentures, M. M. DeVan, Nov. 1 to 6, 1954.

P.G. 24.—Precision Prosthesis and Functional Treatment, Ernest R. Granger, Jan. 17 to 22, 1955.

P.G. 25.—Advanced Practices in Fundamental Treatment, Ernest R. Granger, October 18 to 23, 1954. (Open to those who have completed P.G. 24).

For further information, write to the Director, Postgraduate Courses, School of Dentistry, University of Pennsylvania, 4001 Spruce Street, Philadelphia 4, Pa.

New York University announces an expanded program of postgraduate courses in Periodontia and Oral Medicine under the supervision of Dr. Samuel Charles Miller. For further information write to the Secretary, Postgraduate Division, New York University College of Dentistry, 209 E. 23rd St., New York, N.Y.

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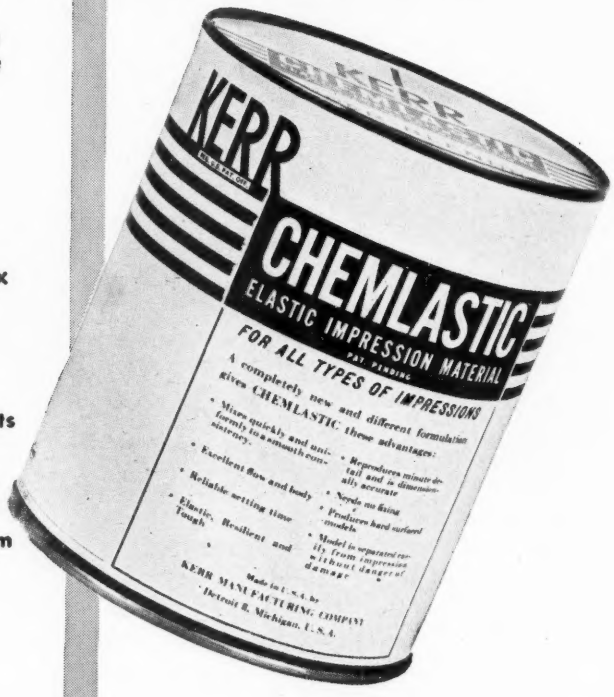

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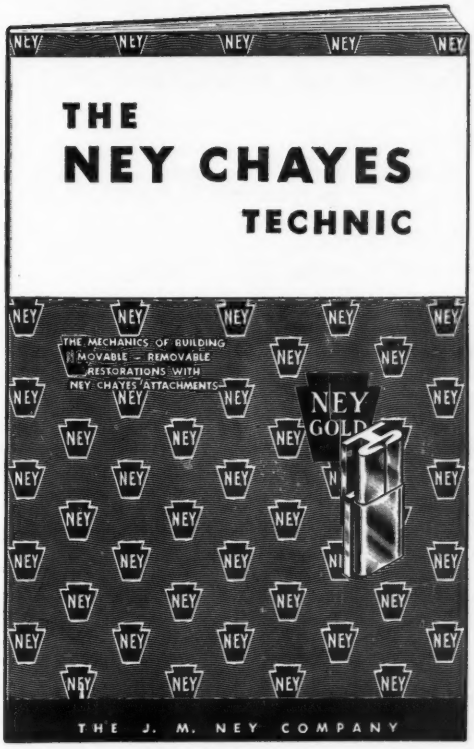

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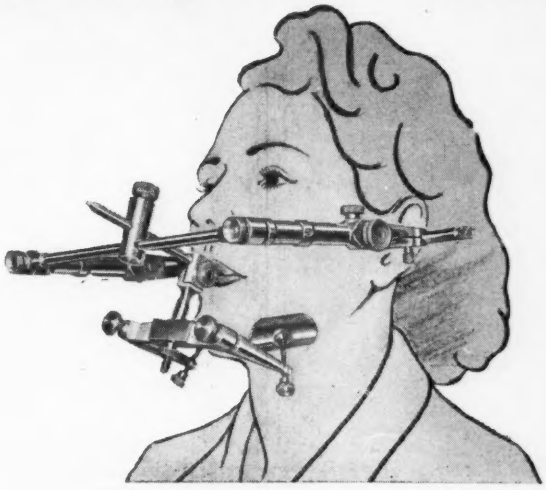

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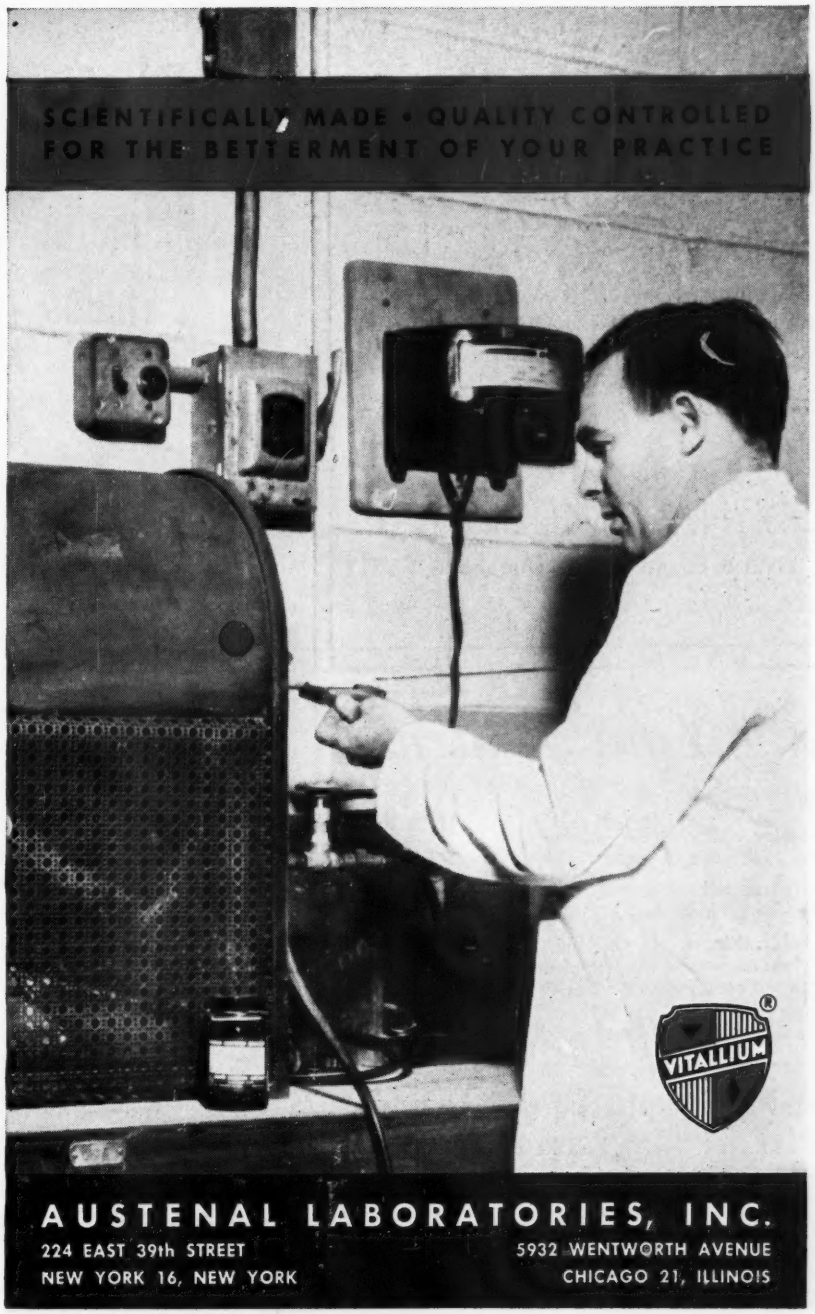
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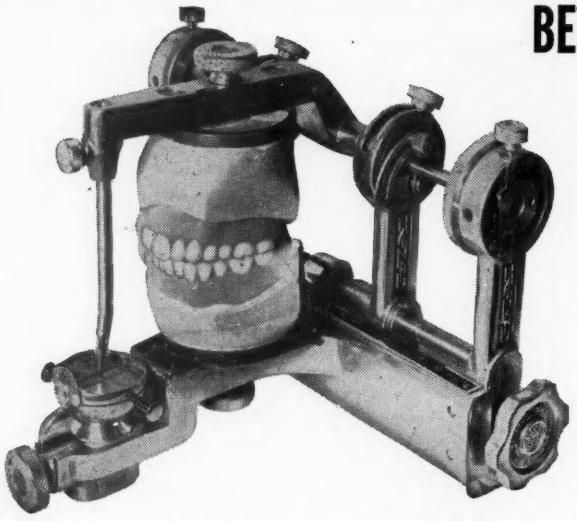

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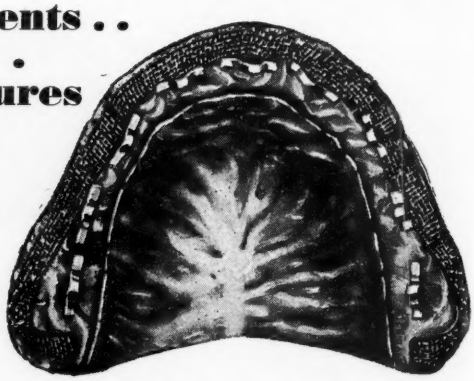

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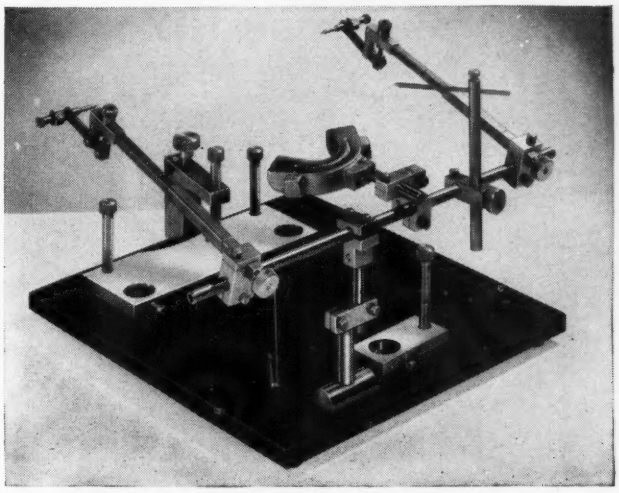

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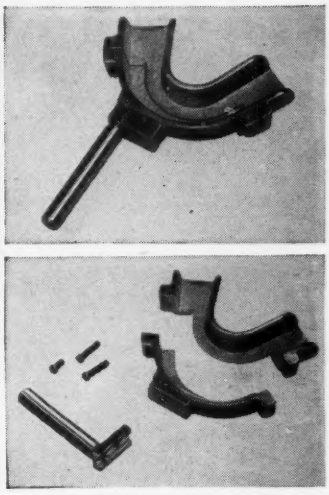

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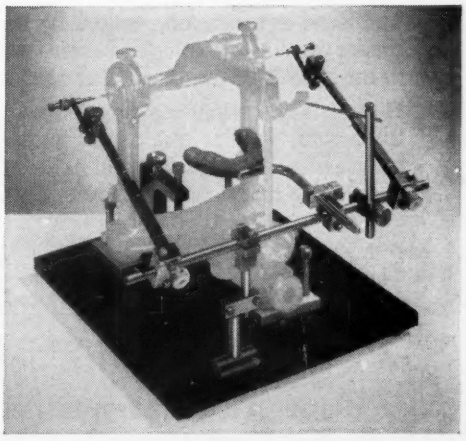

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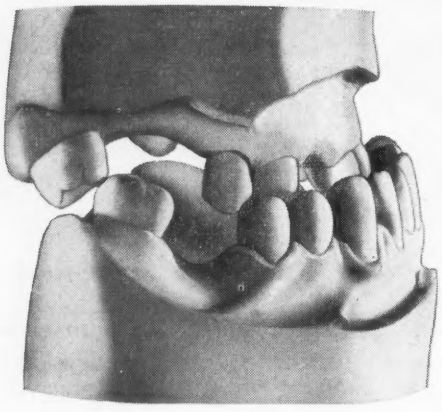

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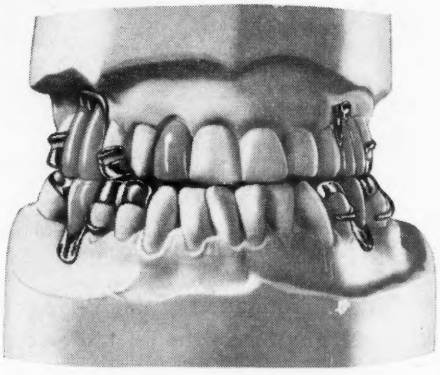

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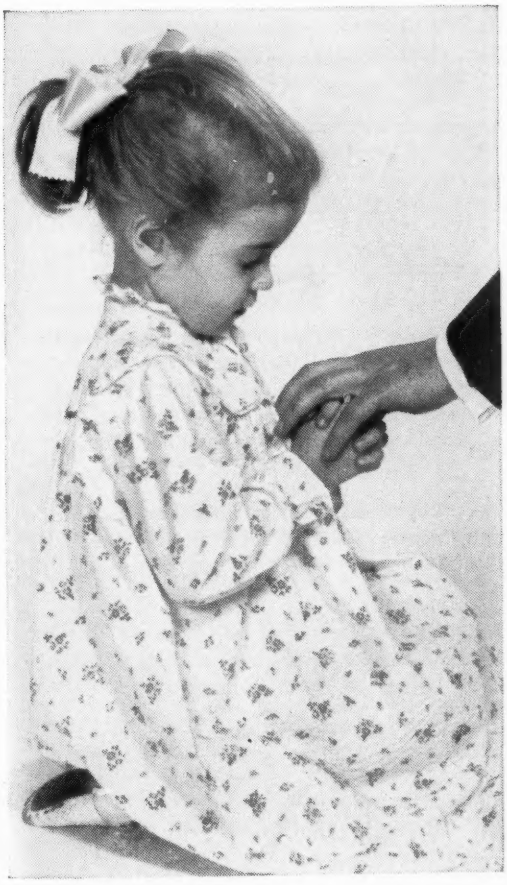

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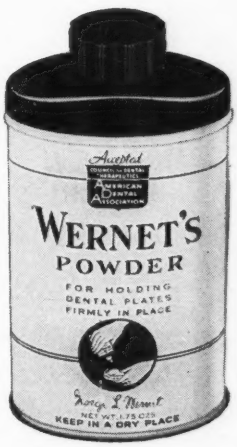

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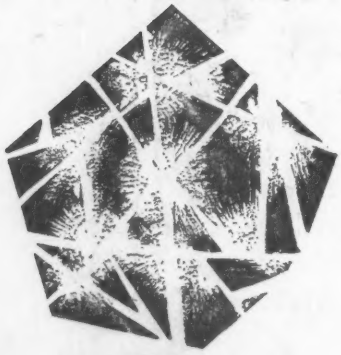

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